

PB-229 660

BACKGROUND INFORMATION FOR PROPOSED  
NEW SOURCE PERFORMANCE STANDARDS:  
ASPHALT CONCRETE PLANTS, PETROLEUM  
REFINERIES, STORAGE VESSELS, SECONDARY  
LEAD SMELTERS AND REFINERIES, BRASS OR  
BRONZE INGOT PRODUCTION PLANTS, IRON AND  
STEEL PLANTS, SEWAGE TREATMENT PLANTS.  
VOLUME 2, APPENDIX: SUMMARIES OF TEST  
DATA

Environmental Protection Agency  
Research Triangle Park, North Carolina

June 1973

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| <b>BIBLIOGRAPHIC DATA SHEET</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |  | 1. Report No.<br>APTD-1352b                      | 2. <b>PB 229 660</b>                |
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| 15. Supplementary Notes                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |  |                                                  |                                     |
| 16. Abstracts. This document provides background information on the derivation of the proposed second group of new source performance standards and their economic impact on the construction and operation of asphalt concrete plants, petroleum refineries, storage vessels secondary lead smelters and refineries, brass or bronze ingot production plants, iron and steel plants, and sewage treatment plants. Information is also provided on the environmental impact of imposing the standards. The standards require control at a level typical of well controlled existing plants and attainable with existing technology. To determine these levels, extensive on-site investigations were conducted, and design factors, maintenance practices, available test data, and the character of emissions were considered. Economic analyses of the effects of the standards indicate they will not cause undue reductions of profit margins or reductions in growth rates. This appendix presents summaries of source tests cited in Volume 1. The summaries are concerned principally with tests for particulate matter and carbon monoxide, but also describe the facilities, characteristics of exhaust gas streams, and conditions of operation. |  |                                                  |                                     |
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# **BACKGROUND INFORMATION FOR PROPOSED NEW SOURCE PERFORMANCE STANDARDS:**



**Asphalt Concrete Plants  
Petroleum Refineries  
Storage Vessels  
Secondary Lead Smelters and Refineries  
Brass or Bronze Ingot Production Plants  
Iron and Steel Plants  
Sewage Treatment Plants**

## **Volume 2, APPENDIX: SUMMARIES OF TEST DATA**

**U. S. ENVIRONMENTAL PROTECTION AGENCY  
Office of Air and Water Programs  
Office of Air Quality Planning and Standards  
Research Triangle Park, North Carolina 27711  
June 1973**

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## INTRODUCTION

This appendix presents summaries of source tests cited in the document. The summaries are concerned principally with tests for particulate matter and carbon monoxide, but also describe the facilities, characteristics of exhaust gas streams, and conditions of operation.

For each source category, facilities are identified by the same coding used in the technical reports. For example, Table A-16 summarizes results of the December 1971 test of petroleum refinery catalytic cracking Facility A. These results are also plotted as Bar A<sub>1</sub> in Figure 3 of the Technical Report Number 7. In this case, the bar represents the range of the two valid results. Table A-17 summarizes a second test, A<sub>2</sub>, conducted in February 1972 at the same facility.

Most of the tests summarized herein were conducted using the reference test methods of 40 CFR 60. Wherever particulate tests were conducted, additional measurements were made to evaluate materials that condense and collect in impingers as the gases are cooled to 70°F. In the summaries, the "probe and filter catch" is the particulate that relates to the standard and the EPA reference method (Method 5 of 40 CFR 60 as published December 23, 1971). The "total catch" includes the probe and filter catch, plus material collected in the impingers using the particulate method as described in 36 FR 15704, published on August 17, 1971.

Where particulate testing was performed using methods other than those cited above, the method is noted under "Facility" in the discussion and also in the appropriate table. Code test methods are listed in the "Introduction" of the main text.

## HOT MIX ASPHALT CONCRETE PLANTS

### PARTICULATE TEST RESULTS

Four hot mix asphalt concrete plants were tested by EPA, one controlled with a high-pressure venturi scrubber and three with baghouses. In addition, State and local control agencies provided data from the testing of four plants controlled with venturi scrubbers and three with baghouses. National Asphalt Pavement Association tests of four plants controlled with baghouses are also included. Two of these are not representative of "best demonstrated technology" because poor collector maintenance or operation was observed during testing. Additional information was available from an EPA study of asphalt concrete plants in the Seattle, Washington, area. The latter plants were not necessarily well controlled and were tested to determine average emission factors.

For each plant, exhaust gases were analyzed after discharge from the particulate collector. These gases included drier exhaust gases and sweep air used to gather dust at various points in the system such as elevators, screens, and scavenger systems. The front and back half catches could not be separated (based on data supplied) for Plants F and G, and therefore are comparable to the catch from the total EPA train.

#### Facilities:

- A<sub>1</sub>. Oil-fired, 120-ton/hr design capacity, equipped with a cyclone and a closed suction-type cyclic-cleaned baghouse designed for 99.9+ percent efficiency. Plant was operating at or near

capacity for conditions prevalent during the test periods.

- A<sub>2</sub>. Same location as plant A<sub>1</sub>. Gas-fired rotary dryer, production rate of 115 tons/hr during sampling, equipped with a cyclone and a baghouse. Opacity was reported to be less than 5 percent. Data provided by the National Asphalt Pavement Association.
- B. Oil-fired, 300-ton/hr design capacity, equipped with a closed suction-type cyclic-cleaned baghouse designed for 99.9+ percent efficiency. Plant was operating at an estimated 80 to 90 percent capacity for conditions prevalent during the test periods.
- C. Oil-fired, 200-ton/hr design capacity, equipped with a cyclone and a high-pressure venturi scrubber operating at 20.4 inches of water pressure drop and approximately 14 gallons of water per 1000 scfm of exhaust gases. Data were provided by a local control agency. The plant was operating at approximately 70 percent and 100 percent of design capacity during the test periods. No exhaust gas opacity readings were available. The air flow rates (dscfm) for this plant were unusually high for a typical 200-ton/hr plant. The plant was not observed or tested by EPA.
- D. Gas-fired, 240-ton/hr design capacity, equipped with a multicyclone and a closed suction-type cyclic-cleaned baghouse designed for 99.9+ percent efficiency. Plant was operating at or near capacity for conditions prevalent during the test periods.
- E. Batch process, 180-ton/hr rated capacity, gas-fired, equipped with a multicyclone and a closed suction-type cyclic-cleaned baghouse designed for 99.9+ percent efficiency. Plant production during

the test period is unknown. Data were provided by a local control agency. No exhaust gas opacity readings were available.

- F. Gas-fired, 250- to 300-ton/hr design capacity, equipped with a cyclone and a closed suction-type cyclic-cleaned baghouse designed for 99.9+ percent efficiency. Plant production during the test periods is unknown. The testing was performed and data were provided by a local control agency. No exhaust gas opacity readings were available.
- G. Gas-fired, 75-ton/hr design capacity, equipped with two cyclones and a high-pressure venturi scrubber operating at 16 inches water pressure drop and approximately 11.5 gallons of water per 1000 scfm of exhaust gases. Tested using Code Method 3. Production rate during the test period was approximately 100 percent of capacity. Data were provided by a local control agency. No exhaust gas opacity readings were available.
- H<sub>1</sub>. Oil-fired, 240-ton/hr design capacity, equipped with a cyclone and a high-pressure venturi operating at 18.5 inches water pressure drop and approximately 18 gallons of water per 1000 scfm of exhaust gas. Plant was operating at capacity for conditions prevalent during the test periods. Exhaust gas opacity readings were not recorded.
- H<sub>2</sub>. Same plant as H<sub>1</sub>. Testing conditions differed in that production rate was 200 tons/hr, the venturi scrubber was operating at 19.5 inches water pressure drop and the test results were provided by a local agency.

- I. Gas-fired, 120-ton/hr design capacity, equipped with a venturi scrubber operating at 26 inches water pressure drop. Plant production data during the test periods is unknown. Testing was performed and data were provided by a State control agency. No exhaust gas opacity readings were available.
- J. Baghouse collector. Data provided by a State control agency. Operating conditions unknown.
- K. Oil-fired rotary dryer, production rate approximately 120 tons/hr, equipped with a cyclone and a baghouse. Data provided by the National Asphalt Pavement Association.
- L. Oil-fired, production rate of 200 tons/hr during sampling, equipped with a cyclone and a baghouse. "Very little visible emissions from stack" observed. Data provided by the National Asphalt Pavement Association.
- M. Oil-fired rotary dryer, production rate varying from 132 to 173 tons/hr during sampling, equipped with a cyclone and a baghouse. Data provided by the National Asphalt Pavement Association.

Table A-1. ASPHALT CONCRETE FACILITY A<sub>1</sub>,

## SUMMARY OF RESULTS

| Run number                      | 1        | 2        | 3        | Average |
|---------------------------------|----------|----------|----------|---------|
| Date                            | 11/15/71 | 11/16/71 | 11/17/71 |         |
| Test time, minutes              | 126      | 63.0     | 63.0     | 84.0    |
| Production rate,<br>tons/hr     | 112      | 89       | 98       | 99.7    |
| Stack effluent                  |          |          |          |         |
| Flow rate, dscfm                | 16,228   | 16,139   | 16,520   | 16,296  |
| Flow rate, dscf/ton<br>product  | 8693     | 10,880   | 10,114   | 9896    |
| Temperature, °F                 | 195      | 196      | 187      | 192.7   |
| Water vapor, vol. %             | 18.35    | 18.38    | 17.48    | 18.07   |
| CO <sub>2</sub> , vol. % dry    | 0.9      | 4.6      | 4.0      | 3.2     |
| O <sub>2</sub> , vol. % dry     | 19.2     | 14.8     | 15.4     | 16.5    |
| CO, vol. % dry                  | 0        | 0.1      | 0.1      | 0.1     |
| Visible emissions,<br>% opacity | <10      | <10      | <10      | <10     |
| Particulate emissions           |          |          |          |         |
| Probe and filter catch          |          |          |          |         |
| gr/dscf                         | 0.0057   | 0.0077   | 0.0068   | 0.0067  |
| gr/acf                          | 0.0037   | 0.0050   | 0.0045   | 0.0044  |
| lb/hr                           | 0.79     | 1.06     | 0.98     | 0.94    |
| lb/ton of<br>product            | 0.007    | 0.011    | 0.010    | 0.009   |
| Total catch                     |          |          |          |         |
| gr/dscf                         | 0.0272   | 0.0194   | 0.0184   | 0.0217  |
| gr/acf                          | 0.0176   | 0.0126   | 0.0122   | 0.0141  |
| lb/hr                           | 3.78     | 2.68     | 2.60     | 3.02    |
| lb/ton of<br>product            | 0.033    | 0.029    | 0.027    | 0.030   |

Table A-2. ASPHALT CONCRETE FACILITY A<sub>2</sub>,

SUMMARY OF RESULTS

|                                 |         |
|---------------------------------|---------|
| Run number                      | 1       |
| Date                            | 7/20/72 |
| Test time, minutes              | 42      |
| Production rate,<br>tons/hr     | 115     |
| Stack effluent                  |         |
| Flow rate, dscfm                | 15,650  |
| Flow rate, dscf/ton<br>product  | 8165    |
| Temperature, °F                 | 218     |
| Water vapor, vol. %             | 28.2    |
| CO <sub>2</sub> , vol. % dry    | 4.5     |
| O <sub>2</sub> , vol. % dry     | 12.8    |
| CO, vol. % dry                  | 0       |
| Visible emissions,<br>% opacity | --      |
| Particulate emissions           |         |
| Probe and filter catch          |         |
| gr/dscf                         | 0.021   |
| gr/acf                          | --      |
| lb/hr                           | 2.8     |
| lb/ton of<br>product            | 0.0243  |

Table A-3. ASPHALT CONCRETE FACILITY B,

## SUMMARY OF RESULTS

| Run number                      | 1        | 2        | 3        | Average |
|---------------------------------|----------|----------|----------|---------|
| Date                            | 11/11/71 | 11/13/71 | 11/13/71 |         |
| Test time, minutes              | 144      | 90       | 90       | 108.0   |
| Production rate,<br>tons/hr     | 203      | 198      | 236      | 212.3   |
| Stack effluent                  |          |          |          |         |
| Flow rate, dscfm                | 19,756   | 21,065   | 22,407   | 21,076  |
| Flow rate, dscf/ton<br>product  | 5839     | 6383     | 5697     | 5973    |
| Temperature, °F                 | 275      | 247      | 234      | 252     |
| Water vapor, vol. %             | 31.71    | 23.71    | 21.78    | 25.73   |
| CO <sub>2</sub> , vol. % dry    | 5.3      | 5.8      | 5.1      | 5.4     |
| O <sub>2</sub> , vol. % dry     | 14.1     | 13.6     | 14.6     | 14.1    |
| CO, vol. % dry                  | 0.05     | 0.05     | 0.05     | 0.05    |
| Visible emissions,<br>% opacity | <10      | <10      | <10      | <10     |
| Particulate emissions           |          |          |          |         |
| Probe and filter catch          |          |          |          |         |
| gr/dscf                         | 0.0079   | 0.0100   | 0.0064   | 0.0081  |
| gr/acf                          | 0.0038   | 0.0056   | 0.0038   | 0.0044  |
| lb/hr                           | 1.34     | 1.80     | 1.23     | 1.46    |
| lb/ton of<br>product            | 0.007    | 0.012    | 0.005    | 0.008   |
| Total catch                     |          |          |          |         |
| gr/dscf                         | 0.1006   | 0.0550   | 0.0168   | 0.0575  |
| gr/acf                          | 0.0490   | 0.0308   | 0.0099   | 0.0299  |
| lb/hr                           | 17.04    | 9.94     | 3.23     | 10.07   |
| lb/ton of<br>product            | 0.089    | 0.066    | 0.014    | 0.056   |

Table A-4. ASPHALT CONCRETE FACILITY C,

## SUMMARY OF RESULTS

| Run number                      | 1                  | 2        | 3        | 4        | Average |
|---------------------------------|--------------------|----------|----------|----------|---------|
| Date                            | 11/18/71           | 11/18/71 | 11/19/71 | 11/19/71 |         |
| Test time, minutes              | --                 | --       | --       | --       |         |
| Production rate,<br>tons/hr     | 130                | 130      | 175      | 175      | 152.5   |
| Stack effluent                  |                    |          |          |          |         |
| Flow rate, dscfm                | 36,522             | 35,399   | 36,148   | 34,883   | 35,738  |
| Flow rate, dscf/ton<br>product  | 16,856             | 16,338   | 12,394   | 11,960   | 14,387  |
| Temperature, °F                 | 90                 | 90       | 90       | 90       | 90      |
| Water vapor, vol. %             | 2.82               | 4.70     | 4.34     | 4.51     | 4.09    |
| CO <sub>2</sub> , vol. % dry    | --                 | --       | --       | --       | --      |
| O <sub>2</sub> , vol. % dry     | No orsat available |          |          |          |         |
| CO, vol. % dry                  | --                 | --       | --       | --       | --      |
| Visible emissions,<br>% opacity | --                 | --       | --       | --       | --      |
| Particulate emissions           |                    |          |          |          |         |
| Probe and filter catch          |                    |          |          |          |         |
| gr/dscf                         | 0.022              | 0.021    | 0.012    | 0.012    | 0.017   |
| gr/acf                          | 0.019              | 0.018    | 0.010    | 0.010    | 0.014   |
| lb/hr                           | 7.09               | 6.68     | 3.89     | 3.82     | 5.37    |
| lb/ton of<br>product            | 0.054              | 0.051    | 0.022    | 0.022    | 0.037   |
| Total catch                     |                    |          |          |          |         |
| gr/dscf                         | 0.024              | 0.024    | 0.013    | 0.013    | 0.018   |
| gr/acf                          | 0.021              | 0.020    | 0.011    | 0.011    | 0.016   |
| lb/hr                           | 7.51               | 7.28     | 4.03     | 3.89     | 5.68    |
| lb/ton of<br>product            | 0.058              | 0.056    | 0.023    | 0.022    | 0.040   |

Table A-5. ASPHALT CONCRETE FACILITY D,

## SUMMARY OF RESULTS

| Run number                      | 1        | 2        | Average |
|---------------------------------|----------|----------|---------|
| Date                            | 10/29/71 | 10/29/71 |         |
| Test time, minutes              | 48       | 48       | 48      |
| Production rate,<br>tons/hr     | 221      | 234      | 222.5   |
| Stack effluent                  |          |          |         |
| Flow rate, dscfm                | 24,028   | 23,919   | 23,974  |
| Flow rate, dscf/ton<br>product  | 6523     | 6133     | 6328    |
| Temperature, °F                 | 238      | 230      | 234     |
| Water vapor, vol. %             | 21.6     | 23.2     | 22.40   |
| CO <sub>2</sub> , vol. % dry    | 3.0      | 4.6      | 3.8     |
| O <sub>2</sub> , vol. % dry     | 14.8     | 12.7     | 13.8    |
| CO, vol. % dry                  | 0        | 0        | 0       |
| Visible emissions,<br>% opacity | <10      | <10      | <10     |
| Particulate emissions           |          |          |         |
| Probe and filter catch          |          |          |         |
| gr/dscf                         | 0.0122   | 0.0234   | 0.0178  |
| gr/acf                          | 0.0071   | 0.0136   | 0.0104  |
| lb/hr                           | 2.49     | 4.80     | 3.64    |
| lb/ton of<br>product            | 0.010    | 0.020    | 0.015   |
| Total catch                     |          |          |         |
| gr/dscf                         | 0.0517   | 0.1281   | 0.0899  |
| gr/acf                          | 0.0302   | 0.0746   | 0.0524  |
| lb/hr                           | 10.64    | 26.26    | 18.45   |
| lb/ton of<br>product            | 0.044    | 0.109    | 0.076   |

Table A-6. ASPHALT CONCRETE FACILITY E,  
SUMMARY OF RESULTS

| Run number                      | 1       | 2        | Average |
|---------------------------------|---------|----------|---------|
| Date                            | 11/4/71 | 11/11/71 |         |
| Test time, minutes              | 65      | 65.4     | 65.2    |
| Production rate,<br>tons/hr     | --      | --       | --      |
| Stack effluent                  |         |          |         |
| Flow rate, dscfm                | 21,706  | 21,651   | 21,678  |
| Flow rate, dscf/ton<br>product  | --      | --       | --      |
| Temperature, °F                 | 262     | 268      | 266     |
| Water vapor, vol. %             | 23.3    | 27.1     | 25.2    |
| CO <sub>2</sub> , vol. % dry    | --      | --       | --      |
| O <sub>2</sub> , vol. % dry     | --      | --       | --      |
| CO, vol. % dry                  | --      | --       | --      |
| Visible emissions,<br>% opacity | --      | --       | --      |
| Particulate emissions           |         |          |         |
| Probe and filter catch          |         |          |         |
| gr/dscf                         | 0.0163  | 0.0215   | 0.0189  |
| gr/acf                          | 0.0093  | 0.0122   | 0.0108  |
| lb/hr                           | 3.03    | 3.99     | 3.51    |
| lb/ton of<br>product            | --      | --       | --      |
| Total catch                     |         |          |         |
| gr/dscf                         | 0.025   | 0.029    | 0.027   |
| gr/acf                          | 0.0142  | 0.0160   | 0.0151  |
| lb/hr                           | 4.74    | 5.47     | 5.10    |
| lb/ton of<br>product            | --      | --       | --      |

Table A-7. ASPHALT CONCRETE FACILITY E,

## SUMMARY OF RESULTS

| Run number                      | 1                                           | 2       | Average |
|---------------------------------|---------------------------------------------|---------|---------|
| Date                            | 9/25/68                                     | 9/26/68 |         |
| Test time, minutes              | 120                                         | 120     | 120     |
| Production rate,<br>tons/hr     | --                                          | --      | --      |
| Stack effluent                  |                                             |         |         |
| Flow rate, dscfm                | 26,160                                      | 26,160  | 26,160  |
| Flow rate, dscf/ton<br>product  | --                                          | --      | --      |
| Temperature, °F                 | 281                                         | 281     | 281     |
| Water vapor, vol. %             | 24                                          | 24      | 24      |
| CO <sub>2</sub> , vol. % dry    | No orsat available                          |         |         |
| O <sub>2</sub> , vol. % dry     | No orsat available                          |         |         |
| CO, vol. % dry                  | No orsat available                          |         |         |
| Visible emissions,<br>% opacity | --                                          | --      | --      |
| Particulate emissions           |                                             |         |         |
| Probe and filter catch          |                                             |         |         |
| gr/dscf                         | Could not be calculated<br>from test report |         |         |
| gr/acf                          |                                             |         |         |
| lb/hr                           |                                             |         |         |
| lb/ton of<br>product            |                                             |         |         |
| Total catch                     |                                             |         |         |
| gr/dscf                         | 0.006                                       | 0.007   | 0.0065  |
| gr/acf                          | 0.003                                       | 0.004   | 0.004   |
| lb/hr                           | 1.35                                        | 1.57    | 1.46    |
| lb/ton of<br>product            | --                                          | --      | --      |

Table A-8. ASPHALT CONCRETE FACILITY G,  
SUMMARY OF RESULTS<sup>a</sup>

| Run number                      | 1                  | 2       | Average |
|---------------------------------|--------------------|---------|---------|
| Date                            | 7/23/70            | 7/23/70 |         |
| Test time, minutes              | 60                 | 60      | 60      |
| Production rate,<br>tons/hr     | 74                 | --      | --      |
| Stack effluent                  |                    |         |         |
| Flow rate, dscfm                | 17,092             | --      | --      |
| Flow rate, dscf/ton<br>product  | 13,858             | --      | --      |
| Temperature, °F                 | 107                | --      | --      |
| Water vapor, vol. %             | 2.0                | --      | --      |
| CO <sub>2</sub> , vol. % dry    | No orsat available |         |         |
| O <sub>2</sub> , vol. % dry     | No orsat available |         |         |
| CO, vol. % dry                  | No orsat available |         |         |
| Visible emissions,<br>% opacity | --                 | --      | --      |
| Particulate emissions           |                    |         |         |
| Probe and filter catch          |                    |         |         |
| gr/dscf                         | 0.0133             | 0.0162  | 0.01525 |
| gr/acf                          | 0.0122             | --      | --      |
| lb/hr                           | 1.994              | --      | --      |
| lb/ton of<br>product            | 0.027              | --      | --      |
| Total catch                     |                    |         |         |
| gr/dscf                         | 0.0143             | --      | --      |
| gr/acf                          | 0.0134             | --      | --      |
| lb/hr                           | 0.029              | --      | --      |
| lb/ton of<br>product            | 2.137              | --      | --      |

<sup>a</sup>Tested by local agency using Code Method 3.

Table A-9. ASPHALT CONCRETE FACILITY H<sub>7</sub>,

## SUMMARY OF RESULTS

| Run number                   | 1       | 2       | 3       | Average |
|------------------------------|---------|---------|---------|---------|
| Date                         | 11/4/71 | 11/4/71 | 11/5/71 |         |
| Test time, minutes           | 54      | 54      | 54      | 54      |
| Production rate, tons/hr     | 176     | 193     | 170     | 180     |
| Stack effluent               |         |         |         |         |
| Flow rate, dscfm             | 28,217  | 28,118  | 26,126  | 27,487  |
| Flow rate, dscf/ton product  | 9619    | 8741    | 9221    | 9194    |
| Temperature, °F              | 112     | 109.1   | 122     | 114     |
| Water vapor, vol. %          | 9.2     | 8.4     | 12.2    | 9.93    |
| CO <sub>2</sub> , vol. % dry | 3.3     | 3.1     | 3.9     | 3.4     |
| O <sub>2</sub> , vol. % dry  | 16.6    | 16.4    | 15.9    | 16.3    |
| CO, vol. % dry               | 0.1     | 0       | 0       | 0       |
| Visible emissions, % opacity | --      | --      | --      | --      |
| Particulate emissions        |         |         |         |         |
| Probe and filter catch       |         |         |         |         |
| gr/dscf                      | 0.0314  | 0.0340  | 0.0292  | 0.0315  |
| gr/acf                       | 0.0259  | 0.0282  | 0.0229  | 0.0257  |
| lb/hr                        | 7.63    | 8.15    | 6.27    | 7.35    |
| lb/ton of product            | 0.043   | 0.042   | 0.037   | 0.041   |
| Total catch                  |         |         |         |         |
| gr/dscf                      | 0.0497  | 0.1087  | 0.0555  | 0.0713  |
| gr/acf                       | 0.0409  | 0.0901  | 0.0435  | 0.0582  |
| lb/hr                        | 12.02   | 26.19   | 12.43   | 16.88   |
| lb/ton of product            | 0.068   | 0.136   | 0.073   | 0.092   |

Table A-10. ASPHALT CONCRETE FACILITY H<sub>2</sub>,

## SUMMARY OF RESULTS

|                                 |          |
|---------------------------------|----------|
| Run number                      | 1        |
| Date                            | 11/17/71 |
| Test time, minutes              | 70       |
| Production rate,<br>tons/hr     | 200      |
| Stack effluent                  |          |
| Flow rate, dscfm                | 29,400   |
| Flow rate, dscf/ton<br>product  | 8820     |
| Temperature, °F                 | 110      |
| Water vapor, vol.%              | 8.7      |
| CO <sub>2</sub> , vol.% dry     | --       |
| O <sub>2</sub> , vol. % dry     | --       |
| CO, vol.% dry                   | --       |
| Visible emissions,<br>% opacity | --       |
| Particulate emissions           |          |
| Probe and filter catch          |          |
| gr/dscf                         | 0.011    |
| gr/acf                          | --       |
| lb/hr                           | --       |
| lb/ton of<br>product            | --       |
| Total catch                     |          |
| gr/dscf                         | 0.022    |
| gr/acf                          | --       |
| lb/hr                           | 5.05     |
| lb/ton of<br>product            | 0.025    |

Table A-11. ASPHALT CONCRETE FACILITY I,

## SUMMARY OF RESULTS

|                                 |         |
|---------------------------------|---------|
| Run number                      | 1       |
| Date                            | 7/17/72 |
| Test time, minutes              | --      |
| Production rate,<br>tons/hr     | --      |
| Stack effluent                  |         |
| Flow rate, dscfm                | 30,460  |
| Flow rate, dscf/ton<br>product  | --      |
| Temperature, °F                 | 175     |
| Water vapor, vol. %             | 15      |
| CO <sub>2</sub> , vol. % dry    | --      |
| O <sub>2</sub> , vol. % dry     | --      |
| CO, vol. % dry                  | --      |
| Visible emissions,<br>% opacity | --      |
| Particulate emissions           |         |
| Probe and filter catch          |         |
| gr/dscf                         | 0.025   |
| gr/acf                          | --      |
| lb/hr                           | 6.45    |
| lb/ton of<br>product            | --      |
| Total catch                     |         |
| gr/dscf                         | 0.026   |
| gr/acf                          | --      |
| lb/hr                           | 6.75    |
| lb/ton of<br>product            | --      |

Table A-12. ASPHALT CONCRETE FACILITY J,  
SUMMARY OF RESULTS

| Run number                      | 1                       | 2       | 3       | Average |
|---------------------------------|-------------------------|---------|---------|---------|
| Date                            | (10/16/72 and 10/17/72) |         |         |         |
| Test time, minutes              | 80                      | 80      | 80      | 80      |
| Production rate,<br>tons/hr     | --                      | --      | --      | --      |
| Stack effluent                  |                         |         |         |         |
| Flow rate, dscfm                | 17,060                  | 17,060  | 17,060  | 17,060  |
| Flow rate, dscf/ton<br>product  | --                      | --      | --      | --      |
| Temperature, °F                 | 268                     | 268     | 268     | 268     |
| Water vapor, vol. %             | 25                      | 25      | 25      | 25      |
| CO <sub>2</sub> , vol. % dry    | --                      | --      | --      | --      |
| O <sub>2</sub> , vol. % dry     | --                      | --      | --      | --      |
| CO, vol. % dry                  | --                      | --      | --      | --      |
| Visible emissions,<br>% opacity | --                      | --      | --      | --      |
| Particulate emissions           |                         |         |         |         |
| Probe and filter catch          |                         |         |         |         |
| gr/dscf                         | 0.00571                 | 0.01142 | 0.01423 | 0.01012 |
| gr/acf                          | --                      | --      | --      | --      |
| lb/hr                           | 2.89                    | 1.894   | 2.301   | 2.362   |
| lb/ton of<br>product            | --                      | --      | --      | --      |

Table A-13. ASPHALT CONCRETE FACILITY K,

## SUMMARY OF RESULTS

| Run number                      | 1       | 2       | 3       | Average |
|---------------------------------|---------|---------|---------|---------|
| Date                            | 8/22/72 | 8/22/72 | 8/22/72 |         |
| Test time, minutes              | 61.25   | 61.25   | 61.25   | 61.25   |
| Production rate,<br>tons/hr     | 120     | 120     | 120     | 120     |
| Stack effluent                  |         |         |         |         |
| Flow rate, dscfm                | 23,000  | 21,700  | 17,800  | 20,500  |
| Flow rate, dscf/ton<br>product  | 11,500  | 10,850  | 8900    | 10,417  |
| Temperature, °F                 | 207     | 205     | 189     | 200     |
| Water vapor, vol. %             | 14.3    | 14.0    | 16      | 14.8    |
| CO <sub>2</sub> , vol. % dry    | 4       | 4       | 4       | 4       |
| O <sub>2</sub> , vol. % dry     | 15      | 15      | 15      | 15      |
| CO, vol. % dry                  | 0       | 0       | 0       | 0       |
| Visible emissions,<br>% opacity | --      | --      | --      | --      |
| Particulate emissions           |         |         |         |         |
| Probe and filter catch          |         |         |         |         |
| gr/dscf                         | 0.0534  | 0.0918  | 0.180   | 0.108   |
| gr/acf                          | --      | --      | --      | --      |
| lb/hr                           | 10.5    | 17.1    | 27.5    | 18.4    |
| lb/ton of<br>product            | 0.0875  | 0.1425  | 0.2291  | 0.1530  |

Table A-14. ASPHALT CONCRETE FACILITY L,

## SUMMARY OF RESULTS

| Run number                      | 1       | 2       | 3       | Average |
|---------------------------------|---------|---------|---------|---------|
| Date                            | 8/21/72 | 8/21/72 | 8/21/72 |         |
| Test time, minutes              | 60      | 60      | 60      | 60      |
| Production rate,<br>tons/hr     | 200     | 200     | 200     | 200     |
| Stack effluent                  |         |         |         |         |
| Flow rate, dscfm                | 29,900  | 30,700  | 27,200  | 29,267  |
| Flow rate, dscf/ton<br>product  | 8970    | 9210    | 8160    | 8780    |
| Temperature, °F                 | 193     | 200     | 200     | 198     |
| Water vapor, vol. %             | 22.3    | 21.0    | 26.7    | 23.3    |
| CO <sub>2</sub> , vol. % dry    | 6       | 6       | 6       | 6       |
| O <sub>2</sub> , vol. % dry     | 12      | 12      | 12      | 12      |
| CO, vol. % dry                  | 0       | 0       | 0       | 0       |
| Visible emissions,<br>% opacity | --      | --      | --      | --      |
| Particulate emissions           |         |         |         |         |
| Probe and filter catch          |         |         |         |         |
| gr/dscf                         | 0.00447 | 0.00402 | 0.0131  | 0.00720 |
| gr/acf                          | --      | --      | --      | --      |
| lb/hr                           | 14.1    | 1.06    | 3.05    | 1.75    |
| lb/ton of<br>product            | 0.0057  | 0.0053  | 0.0152  | 0.0087  |

Table A-15. ASPHALT CONCRETE FACILITY M,

## SUMMARY OF RESULTS

| Run number                      | 1       | 2       | Average |
|---------------------------------|---------|---------|---------|
| Date                            | 7/14/72 | 7/14/72 |         |
| Test time, minutes              | 67.5    | 67.5    | 67.5    |
| Production rate,<br>tons/hr     | 173     | 132     | 153     |
| Stack effluent                  |         |         |         |
| Flow rate, dscfm                | 18,290  | 18,270  | 18,280  |
| Flow rate, dscf/ton<br>product  | 6345    | 8304    | 7325    |
| Temperature, °F                 | 251     | 245     | 248     |
| Water vapor, vol. %             | 27.1    | 26.2    | 26.7    |
| CO <sub>2</sub> , vol. % dry    | 8       | 8       | 8       |
| O <sub>2</sub> , vol. % dry     | 10.6    | 10.6    | 10.6    |
| CO, vol. % dry                  | 0       | 0       | 0       |
| Visible emissions,<br>% opacity | --      | --      | --      |
| Particulate emissions           |         |         |         |
| Probe and filter catch          |         |         |         |
| gr/dscf                         | 0.043   | 0.043   | 0.043   |
| gr/acf                          | --      | --      | --      |
| lb/hr                           | 6.74    | 6.73    | 6.735   |
| lb/ton of<br>product            | 0.0389  | 0.0501  | 0.0445  |

PETROLEUM REFINERIES  
FLUID CATALYTIC CRACKING UNITS

PARTICULATE TEST RESULTS

Stack tests were carried out at four fluid catalytic cracking (FCC) units located in different petroleum refineries. At each installation, carbon monoxide emissions were controlled by the use of an incinerator waste heat boiler (carbon monoxide boiler) and particulate matter by the use of an electrostatic precipitator. Effluent gases were sampled after they had passed through both control devices. At one of the sites tested by EPA, particulate emissions also were measured by refinery personnel. Six other units were tested by a local agency and one by a refinery.

Facilities:

- A. FCC unit of about 55,000-bbl/day capacity, equipped with an electrostatic precipitator followed by a carbon monoxide boiler. Tables A-16 and A-17 summarize results of tests conducted in December 1971 and February 1972. Unit had been onstream about six months and eight months, respectively, following the last major turnaround. Additional source test data were supplied by the refinery and are listed in Table A-21. These were determined using Code Method 6.
- B. FCC unit of about 70,000-bbl/day capacity, equipped with a carbon monoxide boiler followed by an electrostatic precipitator. Unit had been onstream about 10 months following the last

major turnaround at the time of the test. Ammonia was injected into the gas stream ahead of the precipitator as a conditioning agent.

- C. FCC unit of about 65,000-bbl/day capacity, equipped with a carbon monoxide boiler followed by an electrostatic precipitator. Unit had been onstream about 13 months following the last major turnaround. Ammonia was injected into the effluent ahead of the precipitator as a conditioning agent. During the test, a malfunction occurred in the FCC unit.
- D. FCC unit of about 55,000-bbl/day capacity, equipped with an electrostatic precipitator followed by a carbon monoxide boiler. Unit had been onstream about 8 months following the last major turnaround. During the test, an equipment malfunction occurred, invalidating the particulate results.
- E. FCC unit of about 45,000-bbl/day capacity, equipped with an electrostatic precipitator followed by a carbon monoxide boiler. Tested by refinery personnel using Code Method 6 (alundum thimble packed with glass wool followed by a Gelman type A glass fiber filter). Emission data gathered over 18-month period of operation.
- F. FCC unit of about 65,000-bbl/day capacity, equipped with a carbon monoxide boiler followed by an electrostatic precipitator. Tested by local control agency using Code Method 5.

- G. FCC unit of about 30,000-bbl/day capacity, equipped with an electrostatic precipitator followed by a carbon monoxide boiler. Tested by local control agency using Code Method 5.
- H. FCC unit of 45,000-bbl/day capacity, equipped with an electrostatic precipitator followed by a carbon monoxide boiler. Tested by local control agency using Code Method 5.
- I. FCC unit of about 55,000-bbl/day capacity, equipped with an electrostatic precipitator followed by a carbon monoxide boiler. Tested by local control agency using Code Method 5.
- J. FCC unit of about 45,000-bbl/day capacity, equipped with a carbon monoxide boiler followed by an electrostatic precipitator. Tested by local control agency using Code Method 5.
- K. FCC unit of about 55,000-bbl/day capacity, equipped with an electrostatic precipitator followed by a carbon monoxide boiler. Tested by local control agency using Code Method 5.

Table A-16. CATALYTIC CRACKING FACILITY A<sub>1</sub>.

## SUMMARY OF RESULTS

| Run number                              | 1                   | 2        | 3        | Average |
|-----------------------------------------|---------------------|----------|----------|---------|
| Date                                    | 12/16/71            | 12/17/71 | 12/17/71 |         |
| Test time, minutes                      | 120                 | 120      | 120      | 120     |
| Stack effluent                          |                     |          |          |         |
| Flow rate, dscfm                        | 185,200             | 175,600  | 171,100  | 177,300 |
| Temperature, °F                         | 645                 | 655      | 661      | 653     |
| Water vapor, vol. %                     | 17.9                | 19.4     | 19.7     | 19      |
| CO <sub>2</sub> , vol. % dry            | 13                  | 14       | 14       | 14      |
| O <sub>2</sub> , vol. % dry             | 4                   | 4        | 4        | 4       |
| Carbon monoxide emissions, ppm (volume) | 14                  | Nil      | Nil      | 5       |
| Visible emissions, % opacity            | 10                  | 10       | 10       | 10      |
| Particulate emissions                   |                     |          |          |         |
| Probe and filter catch                  |                     |          |          |         |
| gr/dscf                                 | 0.1021 <sup>a</sup> | 0.0156   | 0.0114   | 0.0135  |
| gr/acf                                  | 0.0410              | 0.0061   | 0.0044   | 0.0053  |
| lb/hr                                   | 161.9 <sup>a</sup>  | 23.5     | 16.7     | 20.1    |
| Total catch                             |                     |          |          |         |
| gr/dscf                                 | 0.2866 <sup>a</sup> | 0.0246   | 0.0174   | 0.0210  |
| gr/acf                                  | 0.1150 <sup>a</sup> | 0.0096   | 0.0067   | 0.0034  |
| lb/hr                                   | 455.6               | 37.0     | 25.5     | 31.2    |

<sup>a</sup>Excessive emissions. Test run not considered representative of normal operation, and not included in averages.

Table A-17. CATALYTIC CRACKING FACILITY A<sub>2</sub>,

## SUMMARY OF RESULTS

| Run number                                 | 1       | 2       | 3       | Average |
|--------------------------------------------|---------|---------|---------|---------|
| Date                                       | 2/8/72  | 2/9/72  | 2/10/72 |         |
| Test time, minutes                         | 120     | 120     | 120     | 120     |
| Stack effluent                             |         |         |         |         |
| Flow rate, dscfm                           | 183,800 | 183,900 | 184,700 | 184,100 |
| Temperature, °F                            | 652     | 666     | 686     | 668     |
| Water vapor, vol. %                        | 21.5    | 20.9    | 22.0    | 21.5    |
| CO <sub>2</sub> , vol. % dry               | 11.2    | 12.8    | 13.2    | 12.4    |
| O <sub>2</sub> , vol. % dry                | 6.4     | 4.4     | 4.0     | 4.9     |
| Carbon monoxide emissions, 10 ppm (volume) |         | 9       | 11      | 10      |
| Visible emissions, % opacity               | 10      | 10      | 10      | 10      |
| Particulate emissions                      |         |         |         |         |
| Probe and filter catch                     |         |         |         |         |
| gr/dscf                                    | 0.0233  | 0.0202  | 0.0225  | 0.0220  |
| gr/acf                                     | 0.0088  | 0.0076  | 0.0082  | 0.0082  |
| lb/hr                                      | 36.7    | 31.8    | 35.6    | 34.7    |
| Total catch                                |         |         |         |         |
| gr/dscf                                    | 0.0331  | 0.0272  | 0.0308  | 0.0304  |
| gr/acf                                     | 0.0125  | 0.0102  | 0.0112  | 0.0113  |
| lb/hr                                      | 52.1    | 42.8    | 48.7    | 47.9    |

Table A-18. CATALYTIC CRACKING FACILITY B,

## SUMMARY OF RESULTS

| Run number                                     | 1       | 2       | 3        | Average |
|------------------------------------------------|---------|---------|----------|---------|
| Date                                           | 12/9/71 | 12/9/71 | 12/10/71 |         |
| Test time, minutes                             | 120     | 60      | 60       | 80      |
| Stack effluent                                 |         |         |          |         |
| Flow rate, dscfm                               | 180,600 | 183,500 | 187,000  | 183,700 |
| Temperature, °F                                | 543     | 519     | 547      | 536     |
| Water vapor, vol. %                            | 14.5    | 15.5    | 16.9     | 15.6    |
| CO <sub>2</sub> , vol. % dry                   | 13.0    | 12.0    | 14.0     | 13.0    |
| O <sub>2</sub> , vol. % dry                    | 3.0     | 3.8     | 3.0      | 3.3     |
| Carbon monoxide emissions, Nil<br>ppm (volume) |         | Nil     | Nil      | Nil     |
| Visible emissions,<br>% opacity                | 30      | 30      | 25       | 30      |
| Particulate emissions                          |         |         |          |         |
| Probe and filter catch                         |         |         |          |         |
| gr/dscf                                        | 0.0355  | 0.0364  | 0.0403   | 0.0374  |
| gr/acf                                         | 0.0161  | 0.0166  | 0.0177   | 0.0168  |
| lb/hr                                          | 54.2    | 56.6    | 64.1     | 58.3    |
| Total catch                                    |         |         |          |         |
| gr/dscf                                        | 0.1055  | 0.1320  | 0.1219   | 0.1198  |
| gr/acf                                         | 0.0480  | 0.0602  | 0.0534   | 0.0539  |
| lb/hr                                          | 162.5   | 207.6   | 195.5    | 188.5   |



Table A-20. CATALYTIC CRACKING FACILITY D.

## SUMMARY OF RESULTS

| Run number                              | 1        | 2        | 3        | 4        | Average |
|-----------------------------------------|----------|----------|----------|----------|---------|
| Date                                    | 12/14/71 | 12/15/71 | 12/16/71 | 12/16/71 |         |
| Test time, minutes                      | 160      | 240      | 120      | 120      | 160     |
| Stack effluent                          |          |          |          |          |         |
| Flow rate, dscfm                        | 196,400  | 186,400  | 205,000  | 195,800  | 195,900 |
| Temperature, °F                         | 739      | 732      | 723      | 734      | 732     |
| Water vapor, vol. %                     | 24.7     | 23.2     | 20.6     | 25.9     | 23.6    |
| CO <sub>2</sub> , vol. % dry            | 7.0      | 7.0      | 10.2     | 13.1     | 9.3     |
| O <sub>2</sub> , vol. % dry             | 12.4     | 12.4     | 7.4      | 3.8      | 9.0     |
| Carbon monoxide emissions, ppm (volume) | Nil      | Nil      | Nil      | 6        | Nil     |
| Visible emissions, % opacity            | 15       | 10       | 15       | 15       | 15      |

Table A-21. ADDITIONAL PARTICULATE EMISSION DATA  
FOR CATALYTIC CRACKING FACILITIES

| <u>Facility A<sub>3</sub><sup>a</sup></u> | <u>Stack Effluent<br/>flow rate, dscfm</u> | <u>Concentration</u> |               | <u>Emission<br/>rate,<br/>lb/hr</u> |
|-------------------------------------------|--------------------------------------------|----------------------|---------------|-------------------------------------|
|                                           |                                            | <u>gr/dscf</u>       | <u>gr/acf</u> |                                     |
| Low                                       | 166,000                                    | 0.010                | 0.0031        | 16                                  |
| High                                      | 202,000                                    | 0.021                | 0.0067        | 34                                  |
| Average                                   | 181,000                                    | 0.014                | 0.0044        | 22                                  |
| <u>Facility E<sup>b</sup></u>             |                                            |                      |               |                                     |
| Low                                       | 106,000                                    | 0.015                | 0.0066        | 13.6                                |
| High                                      | 194,000                                    | 0.022                | 0.0094        | 28.2                                |
| Average                                   | 161,000                                    | 0.017                | 0.0076        | 23.3                                |
| <u>Control agency data<sup>c</sup></u>    |                                            |                      |               |                                     |
| Unit F                                    | 169,500                                    | 0.017                | 0.0077        | 24.7                                |
| Unit G                                    | 233,300                                    | 0.018                | 0.0059        | 36.0                                |
| Unit H                                    | 171,600                                    | 0.017                | 0.0062        | 25.0                                |
| Unit I                                    | 224,400                                    | 0.013                | 0.0045        | 25.0                                |
| Unit J                                    | 198,300                                    | 0.020                | 0.0085        | 34.0                                |
| Unit K                                    | 226,900                                    | 0.018                | 0.0061        | 35.0                                |

<sup>a</sup>Data covers 7 months operation with two emission tests per month, alundum thimble plus glass fiber filter (Code Method 6).

<sup>b</sup>Data covers 17 months operation with an emission test about every 2 months, alundum thimble plus glass fiber filter (Code Method 6).

<sup>c</sup>Data supplied by control agency covering 18 emission tests, Los Angeles County APCD method (Code Method 5). Impingers precede filter.

SECONDARY LEAD SMELTERS AND REFINERIES,  
BLAST AND REVERBERATORY FURNACES

Test results are summarized for seven blast furnaces and three reverberatory furnaces. A local agency supplied test data for three of the blast furnaces and one reverberatory furnace. Nine of the 10 furnaces were equipped with baghouses, six employed afterburners to burn combustibles, and two units had scrubbers for control of sulfur dioxide.

Facilities:

- A. Blast furnace rated at 77 tons of lead per day, equipped with an afterburner and baghouse.
- B. Two blast furnaces having a combined rating of 80 tons of lead per day, equipped with an afterburner, baghouse, and venturi scrubber, calcium hydroxide liquor circulated in scrubber.
- C. Blast furnace rated at 45 tons of lead per day, equipped with a caustic venturi scrubber, sodium hydroxide liquor circulated in scrubber.
- D. Blast furnace having an estimated production rate of 90 tons of lead per day, equipped with afterburner and baghouse. Tested by local agency using Code Method 9.
- E. Blast furnace having an estimated production of 20 tons of lead per day, equipped with afterburner and baghouse. Tested by local agency using Code Method 9.

- F. Blast furnace having an estimated production rate of 52 tons of lead per day, equipped with afterburner and baghouse. Tested by local agency using Code Method 9.
- G. Reverberatory furnace rated at 40 tons of lead per day, equipped with baghouse.
- H. Reverberatory furnace rated at 65 tons of lead per day, equipped with baghouse.
- I. Reverberatory furnace having an estimated production of 20 tons of lead per day, equipped with a baghouse. Tested by local agency using Code Method 9.

Table A-22. LEAD SMELTING FACILITY A,

## SUMMARY OF RESULTS

| Run number                                | 1        | 2        | 3                | Average |
|-------------------------------------------|----------|----------|------------------|---------|
| Date                                      | 11/17/71 | 11/18/71 | 11/18/71         |         |
| Test time, minutes                        | 91       | 188      | 186              | 155     |
| Lead production, tons/hr                  | 3.7      | 2.5      | 3.0 <sup>a</sup> | 3.1     |
| Stack effluent                            |          |          |                  |         |
| Flow rate, dscfm                          | 23,200   | 22,900   | 23,120           | 23,070  |
| Flow rate, dscf/ton                       | 376,200  | 549,600  | 462,400          | 462,700 |
| Temperature, °F                           | 176      | 182      | 177              | 178     |
| Water vapor, vol. %                       | 3.7      | 2.3      | 3.1              | 3.0     |
| CO <sub>2</sub> , vol. % dry              | 2.2      | 2.1      | 1.5              | 1.9     |
| O <sub>2</sub> , vol. % dry               | 19.0     | 19.0     | 19.5             | 19.2    |
| CO emissions, vol. % dry                  | 0.5      | 0.2      | 0.4              | 0.36    |
| CO emissions, lb/hr                       | 503      | 199      | 401              | 368     |
| SO <sub>2</sub> emissions, ppm dry        | 443      | 264      | 204              | 304     |
| SO <sub>2</sub> emissions, lb/hr          | 101      | 59       | 46               | 69      |
| Visible emissions,<br>% opacity           | 10 to 15 | 10 to 70 | 5 to 15          | 12      |
| Particulate emissions                     |          |          |                  |         |
| Probe and filter catch                    |          |          |                  |         |
| gr/dscf                                   | 0.0028   | 0.0027   | 0.0023           | 0.0026  |
| gr/acf                                    | 0.0022   | 0.0021   | 0.0018           | 0.0020  |
| lb/hr                                     | 0.5541   | 0.5231   | 0.4570           | 0.5114  |
| lb/ton lead                               | 0.1498   | 0.2092   | 0.1523           | 0.1704  |
| Total catch                               |          |          |                  |         |
| gr/dscf                                   | --       | 0.0471   | 0.0396           | 0.0434  |
| gr/acf                                    | --       | 0.0368   | 0.0310           | 0.0339  |
| lb/hr                                     | --       | 9.2439   | 7.8566           | 8.5503  |
| lb/ton lead                               | --       | 3.6976   | 2.6189           | 3.1583  |
| Lead emissions                            |          |          |                  |         |
| Probe and filter catch                    |          |          |                  |         |
| gr/dscf                                   | --       | 0.00035  | 0.00033          | 0.00034 |
| gr/acf                                    | --       | 0.00027  | 0.00026          | 0.00027 |
| lb/hr                                     | --       | 0.0679   | 0.0648           | 0.0664  |
| lb/ton lead                               | --       | 0.0272   | 0.0216           | 0.0244  |
| Total catch                               |          |          |                  |         |
| Essentially the same as probe and filter. |          |          |                  |         |

<sup>a</sup>The lead holding pot level was altered by plant personnel during this test and a rate based on average production figures was assumed.

Table A-23. LEAD SMELTING FACILITY B,

| SUMMARY OF RESULTS                        |                   |          |                   |         |
|-------------------------------------------|-------------------|----------|-------------------|---------|
| Run number                                | 1                 | 2        | 3                 | Average |
| Date                                      | 12/15/71          | 12/16/71 | 12/16/71          |         |
| Test time, minutes                        | 195               | 200      | 200               | 198     |
| Lead production, tons/hr                  | 4.2               | 4.9      | 3.5               | 4.2     |
| Stack effluent                            |                   |          |                   |         |
| Flow rate, dscfm                          | 32,060            | 29,420   | 38,060            | 32,960  |
| Flow rate, dscf/ton                       | 458,000           | 360,200  | 652,500           | 490,200 |
| Temperature, °F                           | 124               | 121      | 118               | 121     |
| Water vapor, vol. %                       | 6.34              | 10.33    | 11.04             | 9.24    |
| CO <sub>2</sub> , vol. % dry              | 3.2               | 2.8      | 3.4               | 3.1     |
| O <sub>2</sub> , vol. % dry               | 16.8              | 17.0     | 16.4              | 16.7    |
| CO emissions, vol. % dry                  | <0.1              | 0.2      | 0.4               | 0.23    |
| CO emissions, lb/hr                       | 139               | 255      | 660               | 350     |
| SO <sub>2</sub> emissions, ppm dry        | 1050              | 310      | 138               | 499     |
| SO <sub>2</sub> emissions, lb/hr          | 334               | 90       | 52                | 159     |
| SO <sub>2</sub> inlet, ppm dry            | 1680 <sup>a</sup> | 1100     | 1900 <sup>b</sup> | 1560    |
| SO <sub>2</sub> inlet, lb/hr              | 534               | 321      | 718               | 524     |
| Visible emissions, % opacity              | --                | --       | --                | --      |
| Particulate emissions                     |                   |          |                   |         |
| Probe and filter catch                    |                   |          |                   |         |
| gr/dscf                                   | 0.0079            | 0.0042   | 0.0115            | 0.0079  |
| gr/acf                                    | 0.0066            | 0.0033   | 0.0094            | 0.0064  |
| lb/hr                                     | 2.1743            | 1.0551   | 3.7600            | 2.3298  |
| lb/ton lead                               | 0.5177            | 0.2153   | 1.0743            | 0.6024  |
| Total catch                               |                   |          |                   |         |
| gr/dscf                                   | 0.0417            | 0.0364   | 0.0454            | 0.0412  |
| gr/acf                                    | 0.0348            | 0.0290   | 0.0372            | 0.0366  |
| lb/hr                                     | 11.4461           | 9.1715   | 14.8245           | 11.8140 |
| lb/ton lead                               | 2.7253            | 1.8717   | 4.2356            | 2.9442  |
| Lead emissions                            |                   |          |                   |         |
| Probe and filter catch                    |                   |          |                   |         |
| gr/dscf                                   | 0.00011           | 0.00013  | 0.00016           | 0.00013 |
| gr/acf                                    | 0.00009           | 0.00010  | 0.00013           | 0.00011 |
| lb/hr                                     | 0.0300            | 0.0328   | 0.0506            | 0.0378  |
| lb/ton lead                               | 0.0070            | 0.0067   | 0.0145            | 0.0094  |
| Total catch                               |                   |          |                   |         |
| Essentially the same as probe and filter. |                   |          |                   |         |

<sup>a</sup>Scrubber pH acid for portions of test (control efficient lowered).<sup>b</sup>Scrubber operating properly.

Table A-24. LEAD SMELTING FACILITY C,

## SUMMARY OF RESULTS

| Run number                               | 1        | 2        | 3       | Average |
|------------------------------------------|----------|----------|---------|---------|
| Date                                     | 12/8/71  | 12/9/71  | 12/9/71 |         |
| Test time, minutes                       | 120      | 112      | 112     | 115     |
| Lead production, tons/hr                 | 1.5      | 1.2      | 1.2     | 1.3     |
| Stack effluent                           |          |          |         |         |
| Flow rate, dscfm                         | 12,100   | 13,330   | 12,540  | 12,657  |
| Flow rate, dscf/ton                      | 484,000  | 666,500  | 627,000 | 592,500 |
| Temperature, °F                          | 97       | 95       | 93      | 95      |
| Water vapor, vol. %                      | 2.4      | 1.7      | 2.3     | 2.13    |
| CO <sub>2</sub> , vol. % dry             | 0.5      | 0.8      | 0.8     | 0.7     |
| O <sub>2</sub> , vol. % dry              | 20.3     | 20.2     | 18.8    | 19.7    |
| CO emissions, vol. % dry                 | 0.8      | 0.3      | 0.2     | 0.4     |
| CO emissions, lb/hr                      | 420      | 160      | 109     | 330     |
| SO <sub>2</sub> emissions, ppm dry       | 0.06     | 0.04     | 0.08    | 0.06    |
| SO <sub>2</sub> emissions, lb/hr         | 0.01     | 0.01     | 0.01    | 0.01    |
| Visible emissions,<br>% opacity          | 10 to 15 | 10 to 20 | 5 to 15 | 12      |
| Particulate emissions                    |          |          |         |         |
| Probe and filter catch                   |          |          |         |         |
| gr/dscf                                  | 0.0196   | 0.0084   | 0.0149  | 0.0143  |
| gr/acf                                   | 0.0184   | 0.0080   | 0.0140  | 0.0135  |
| lb/hr                                    | 2.0354   | 0.8913   | 1.6061  | 1.5109  |
| lb/ton lead                              | 1.3570   | 0.7750   | 1.2849  | 1.1389  |
| Total catch                              |          |          |         |         |
| gr/dscf                                  | 0.0275   | 0.0157   | 0.0235  | 0.0222  |
| gr/acf                                   | 0.0257   | 0.0149   | 0.0221  | 0.0208  |
| lb/hr                                    | 2.8474   | 1.6556   | 2.5200  | 2.3410  |
| lb/ton lead                              | 1.8983   | 1.4397   | 2.0160  | 1.7847  |
| Lead emissions                           |          |          |         |         |
| Probe and filter catch                   |          |          |         |         |
| gr/dscf                                  | 0.00127  | 0.00061  | 0.00127 | 0.00105 |
| gr/acf                                   | 0.00119  | 0.00058  | 0.00120 | 0.00099 |
| lb/hr                                    | 0.1320   | 0.0646   | 0.1368  | 0.1111  |
| lb/ton lead                              | 0.0880   | 0.0562   | 0.1095  | 0.0846  |
| Total catch                              |          |          |         |         |
| Essentially the same as probe and filter |          |          |         |         |

Table A-25. LEAD SMELTING FACILITY D,

SUMMARY OF RESULTS<sup>a</sup>

|                                    |                 |
|------------------------------------|-----------------|
| Lead production, tons/hr           | 3.9 (estimated) |
| Stack effluent                     |                 |
| Flow rate, dscfm                   | 20,900          |
| Flow rate, dscf/ton                | 321,500         |
| Temperature, °F                    | 152             |
| Water vapor, vol. %                | 8.7             |
| CO <sub>2</sub> , vol. % dry       | 4.2             |
| O <sub>2</sub> , vol. % dry        | 16.8            |
| CO emissions, vol. % dry           | 1.5             |
| CO emissions, lb/hr                | 1363            |
| SO <sub>2</sub> emissions, ppm dry | 1170            |
| SO <sub>2</sub> emissions, lb/hr   | 248             |
| Visible emissions, % opacity       | 0               |
| Particulate emissions              |                 |
| Probe and filter catch             |                 |
| gr/dscf                            | 0.0013          |
| gr/acf                             | 0.0010          |
| lb/hr                              | 0.233           |
| lb/ton lead                        | 0.060           |
| Total catch                        |                 |
| gr/dscf                            | 0.0075          |
| gr/acf                             | 0.0059          |
| lb/hr                              | 1.344           |
| lb/ton lead                        | 0.345           |
| Lead emissions                     |                 |
| Probe and filter catch             |                 |
| gr/dscf                            | 0.00061         |
| gr/acf                             | 0.00048         |
| lb/hr                              | 0.1093          |
| lb/ton lead                        | 0.0280          |

<sup>a</sup>Tested by local agency using Code Method 9.

Table A-26. LEAD SMELTING FACILITY E,

SUMMARY OF RESULTS<sup>a</sup>

|                                    |                 |
|------------------------------------|-----------------|
| Lead production, tons/hr           | 0.8 (estimated) |
| Stack effluent                     |                 |
| Flow rate, dscfm                   | 13,000          |
| Flow rate, dscf/ton                | 975,000         |
| Temperature, °F                    | 175             |
| Water vapor, vol. %                | 3.9             |
| SO <sub>2</sub> emissions, ppm dry | 300             |
| SO <sub>2</sub> emissions, lb/hr   | 40              |
| Visible emissions, % opacity       | 0               |
| Particulate emissions              |                 |
| Probe and filter catch             |                 |
| gr/dscf                            | 0.0059          |
| gr/acf                             | 0.0047          |
| lb/hr                              | 0.657           |
| lb/ton lead                        | 0.822           |
| Total catch                        |                 |
| gr/dscf                            | 0.0350          |
| gr/acf                             | 0.0281          |
| lb/hr                              | 3.900           |
| lb/ton lead                        | 4.875           |

<sup>a</sup>Tested by local agency using Code Method 9.

Table A-27. LEAD SMELTING FACILITY F,  
SUMMARY OF RESULTS<sup>a</sup>

|                              |                 |
|------------------------------|-----------------|
| Lead production, tons/hr     | 2.2 (estimated) |
| Stack effluent               |                 |
| Flow rate, dscfm             | 7500            |
| Flow rate, dscf/ton          | 204,500         |
| Temperature, °F              | 110             |
| Visible emissions, % opacity | 10 to 30        |
| Particulate emissions        |                 |
| Probe and filter catch       |                 |
| gr/dscf                      | 0.0142          |
| lb/hr                        | 0.913           |
| lb/ton lead                  | 0.415           |
| Total catch                  |                 |
| gr/dscf                      | 0.084           |
| lb/hr                        | 5.400           |
| lb/ton lead                  | 2.455           |

<sup>a</sup>Tested by local agency using Code Method 9.

Table A-28. LEAD SMELTING FACILITY G,

## SUMMARY OF RESULTS

| Run number                         | 1       | 2       | 3       | Average |
|------------------------------------|---------|---------|---------|---------|
| Date                               | 1/26/72 | 1/26/72 | 1/26/72 |         |
| Test time, minutes                 | 120     | 120     | 120     | 120     |
| Lead production, tons/hr           | 2.1     | 2.1     | 2.1     | 2.1     |
| Stack effluent                     |         |         |         |         |
| Flow rate, dscfm                   | 14,600  | 15,200  | 14,200  | 14,667  |
| Flow rate, dscf/ton                | 417,100 | 434,300 | 405,700 | 419,000 |
| Temperature, °F                    | 166     | 164     | 175     | 168     |
| Water vapor, vol. %                | 3.1     | 2.8     | 3.1     | 3.0     |
| CO <sub>2</sub> , vol. % dry       | 1.8     | 1.8     | 1.8     | 1.8     |
| O <sub>2</sub> , vol. % dry        | 18.6    | 18.7    | 18.7    | 18.7    |
| CO emissions, vol. % dry           | <0.1    | <0.1    | <0.1    | <0.1    |
| CO emissions, lb/hr                | 63.5    | 66.0    | 61.7    | 63.7    |
| SO <sub>2</sub> emissions, ppm dry | 1580    | 1525    | 1618    | 1574    |
| SO <sub>2</sub> emissions, lb/hr   | 229     | 230     | 228     | 229     |
| Visible emissions, % opacity       | 0       | 0       | 0       | 0       |
| Particulate emissions              |         |         |         |         |
| Probe and filter catch             |         |         |         |         |
| gr/dscf                            | 0.0043  | 0.0028  | 0.0035  | 0.0035  |
| gr/acf                             | 0.0035  | 0.0023  | 0.0028  | 0.0029  |
| lb/hr                              | 0.5387  | 0.3702  | 0.4297  | 0.4462  |
| lb/ton lead                        | 0.2565  | 0.1763  | 0.2046  | 0.2125  |
| Total catch                        |         |         |         |         |
| gr/dscf                            | 0.0132  | 0.0086  | 0.0200  | 0.0139  |
| gr/acf                             | 0.0170  | 0.0070  | 0.0161  | 0.0113  |
| lb/hr                              | 1.6520  | 1.1148  | 2.4321  | 1.7330  |
| lb/ton lead                        | 0.7867  | 0.5309  | 1.1581  | 0.8252  |
| Lead emissions                     |         |         |         |         |
| Probe and filter catch             |         |         |         |         |
| gr/dscf                            | 0.00090 | 0.00049 | 0.00045 | 0.00061 |
| gr/acf                             | 0.00073 | 0.00040 | 0.00037 | 0.00050 |
| lb/hr                              | 0.1130  | 0.0640  | 0.0553  | 0.0775  |
| lb/ton lead                        | 0.0538  | 0.0305  | 0.0263  | 0.0369  |
| Total catch                        |         |         |         |         |
| gr/dscf                            | 0.0010  | --      | --      | 0.0010  |
| gr/acf                             | 0.00081 | --      | --      | 0.00081 |
| lb/hr                              | 0.1262  | --      | --      | 0.1262  |
| lb/ton lead                        | 0.0601  | --      | --      | 0.0601  |

Table A-29. LEAD SMELTING FACILITY H,

## SUMMARY OF RESULTS

| Run number                         | 1       | 2       | 3       | Average |
|------------------------------------|---------|---------|---------|---------|
| Date                               | 2/9/72  | 2/9/72  | 2/10/72 |         |
| Test time, minutes                 | 150     | 150     | 150     | 150     |
| Lead production, tons/hr           | 2.4     | 2.4     | 2.4     | 2.4     |
| Stack effluent                     |         |         |         |         |
| Flow rate, dscfm                   | 23,480  | 22,600  | 19,940  | 22,007  |
| Flow rate, dscf/ton                | 587,000 | 565,000 | 498,500 | 550,200 |
| Temperature, °F                    | 124     | 132     | 117     | 124     |
| Water vapor, vol. %                | 4.0     | 4.6     | 4.2     | 4.3     |
| CO <sub>2</sub> , vol. % dry       | 2.4     | 2.5     | 2.0     | 2.3     |
| O <sub>2</sub> , vol. % dry        | 18.2    | 18.0    | 18.2    | 18.1    |
| CO emissions, vol. % dry           | <0.1    | <0.1    | <0.1    | <0.1    |
| CO emissions, lb/hr                | <102    | <98     | <87     | <96     |
| SO <sub>2</sub> emissions, ppm dry | 2060    | 2111    | 1930    | 2034    |
| SO <sub>2</sub> emissions, lb/hr   | 480     | 473     | 381     | 445     |
| Visible emissions, % opacity       | 0       | 0       | 0       | 0       |
| Particulate emissions              |         |         |         |         |
| Probe and filter catch             |         |         |         |         |
| gr/dscf                            | 0.0024  | 0.0033  | 0.0042  | 0.0033  |
| gr/acf                             | 0.0021  | 0.0027  | 0.0036  | 0.0028  |
| lb/hr                              | 0.4890  | 0.6350  | 0.7205  | 0.6148  |
| lb/ton lead                        | 0.2038  | 0.2646  | 0.3002  | 0.2562  |
| Total catch                        |         |         |         |         |
| gr/dscf                            | 0.0118  | 0.0131  | 0.0164  | 0.0138  |
| gr/acf                             | 0.0100  | 0.0109  | 0.0140  | 0.0860  |
| lb/hr                              | 2.3737  | 2.5398  | 2.7950  | 2.5695  |
| lb/ton lead                        | 0.9890  | 1.0583  | 1.1646  | 1.071   |
| Lead emissions                     |         |         |         |         |
| Probe and filter catch             |         |         |         |         |
| gr/dscf                            | 0.00034 | 0.00039 | 0.00041 | 0.00038 |
| gr/acf                             | 0.00029 | 0.00033 | 0.00035 | 0.00032 |
| lb/hr                              | 0.0692  | 0.0763  | 0.0695  | 0.0717  |
| lb/ton lead                        | 0.0288  | 0.0318  | 0.0289  | 0.0298  |
| Total catch                        |         |         |         |         |
| gr/dscf                            | 0.00050 | --      | --      | 0.00050 |
| gr/acf                             | 0.00043 | --      | --      | 0.00043 |
| lb/hr                              | 0.1035  | --      | --      | 0.1035  |
| lb/ton lead                        | 0.0432  | --      | --      | 0.0432  |

Table A-30. LEAD SMELTING FACILITY I,

SUMMARY OF RESULTS<sup>a</sup>

|                                    |                  |
|------------------------------------|------------------|
| Lead production, tons/hr           | 0.85 (estimated) |
| Stack effluent                     |                  |
| Flow rate, dscfm                   | 10,400           |
| Flow rate, dscf/ton                | 734,100          |
| Temperature, °F                    | 327              |
| SO <sub>2</sub> emissions, ppm dry | 1039             |
| SO <sub>2</sub> emissions, lb/hr   | 110              |
| Visible emissions, % opacity       | 0                |
| Particulate emissions              |                  |
| Probe and filter catch             |                  |
| gr/dscf                            | 0.0022           |
| lb/hr                              | 0.196            |
| lb/ton lead                        | 0.231            |
| Total catch                        |                  |
| gr/dscf                            | 0.0130           |
| lb/hr                              | 1.159            |
| lb/ton lead                        | 1.363            |

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<sup>a</sup>Tested by local agency using Code Method 9.

## SECONDARY BRASS AND BRONZE REFINING

The data summarized herein cover 13 brass and bronze ingot production furnaces at 9 different test sites. Tests A<sub>1</sub>, B, and D were conducted by EPA and EPA contractors. Tests C, E, F, and I were conducted as part of a 1968 study performed jointly by the Brass and Bronze Ingot Institute and the National Air Pollution Control Administration, an EPA predecessor. Tests A<sub>2</sub>, G, and H were conducted by local control agencies.

### Facilities:

- A. Gas-fired rotary (rotating reverberatory) furnace, 7.5-ton capacity, equipped with two closed suction-type manually cleaned baghouses with a total cloth area of 7181 square feet. Tested by EPA and by local agency, the latter using Code Method 10.
- B. Gas-fired reverberatory (stationary reverberatory) furnace, 100-ton capacity, equipped with a closed suction-type cyclic-cleaned baghouse with a cloth area of 9000 square feet.
- C. Gas-fired reverberatory furnace, 60-ton capacity, equipped with a closed suction-type cyclic-cleaned baghouse with a cloth area of 5940 square feet. Testing using Code Method 4.
- D. Oil-fired rotary furnace, 20-ton capacity, equipped with a closed pressure-type cyclic-cleaned baghouse with a cloth area of 18,661 square feet.

- E. Gas-fired reverberatory furnace, 100-ton capacity, equipped with a closed suction-type cyclic-cleaned baghouse with a cloth area of 7360 square feet. Tested using Code Method 4.
- F. Gas-fired rotary furnace, 17.5-ton capacity, equipped with a closed suction-type cyclic-cleaned baghouse with a cloth area of 20,866 square feet. Tested using Code Method 4.
- G. Two rotary furnaces with a total capacity of 55 tons, equipped with two closed suction-type baghouses with a total cloth area of 41,700 square feet. Probe and filter catch were not analyzed separately.
- H. Two rotary furnaces with a total capacity of 27.5 tons, equipped with three closed suction-type baghouses with a total cloth area of 9536 square feet. Probe and filter catch were not analyzed separately.
- I. One 7.5-ton rotary furnace, one 17.5-ton rotary furnace, and one blast furnace, which was being preheated. All three furnaces were ducted to a closed suction-type cyclic-cleaned baghouse with a cloth area of 20,866 square feet. Tested using Code Method 4.

Table A-31. BRASS AND BRONZE FACILITY A<sub>1</sub>.

## SUMMARY OF RESULTS

| Run number                     | 1        | 2           | 3        | Average |
|--------------------------------|----------|-------------|----------|---------|
| Date                           | 11/10/71 | 11/10-11/71 | 11/12/71 |         |
| Test time, minutes             | 582      | 771         | 733      | 695     |
| Heat time, minutes             | 938      | 922         | 912      | 924     |
| Ingots produced per heat, tons | 6.66     | 7.80        | 7.21     | 7.22    |
| Zinc in alloy produced, %      | 40       | 37          | 40       | 39      |
| Stack effluent                 |          |             |          |         |
| Flow rate, dscfm               | 13,539   | 13,490      | 13,676   | 13,568  |
| Temperature, °F                | 84.9     | 103.5       | 106.2    | 98.2    |
| Water vapor, vol. %            | 3.303    | 3.227       | 3.139    | 3.223   |
| CO <sub>2</sub> , vol. % dry   | 0.6      | 1.0         | 0.3      | 0.6     |
| O <sub>2</sub> , vol. % dry    | 18.4     | 16.8        | 17.4     | 17.5    |
| CO, vol. % dry                 | Nil      | Nil         | Nil      | Nil     |
| Visible emissions, % opacity   | <10      | <10         | <10      | <10     |
| Particulate emissions          |          |             |          |         |
| Probe and filter catch         |          |             |          |         |
| gr/dscf                        | 0.002    | 0.0005      | 0.0003   | 0.001   |
| gr/acf                         | 0.001    | 0.0005      | 0.0002   | 0.0006  |
| lb/hr                          | 0.165    | 0.065       | 0.010    | 0.080   |
| lb/ton of product              | 0.388    | 0.127       | 0.066    | 0.194   |
| Total catch                    |          |             |          |         |
| gr/dscf                        | 0.0047   | 0.0011      | 0.0016   | 0.0024  |
| gr/acf                         | 0.0043   | 0.0010      | 0.0014   | 0.0022  |
| lb/hr                          | 0.521    | 0.129       | 0.185    | 0.278   |
| lb/ton of product              | 1.22     | 0.25        | 0.37     | 0.61    |

Table A-32. BRASS AND BRONZE FACILITY A<sub>2</sub>,

SUMMARY OF RESULTS<sup>a</sup>

|                                     |         |
|-------------------------------------|---------|
| Run number                          | 1       |
| Date                                | 5/11/71 |
| Zinc in alloy produced, % (approx.) | 40      |
| Stack effluent                      |         |
| Flow rate, dscfm                    | 15,468  |
| Temperature, °F                     | 125     |
| Particulate emissions               |         |
| Total catch                         |         |
| gr/dscf                             | 0.0023  |
| lb/hr                               | 0.286   |

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<sup>a</sup>Tested by local agency using Code Method 10. Probe and filter catch not analyzed separately.

Table A-33. BRASS AND BRONZE FACILITY B,

## SUMMARY OF RESULTS

| Run number                      | 1       | 2         | 3         | 4         | Average |
|---------------------------------|---------|-----------|-----------|-----------|---------|
| Date                            | 11/1/71 | 11/2-3/71 | 11/3-4/71 | 11/4-5/71 |         |
| Test time, minutes              | 120     | 700       | 747       | 780       | 656     |
| Heat time, minutes              | 1140    | 1183      | 1326      | 1372      | 1255    |
| Ingots produced per heat, tons  | 49.09   | 59.86     | 56.36     | 53.93     | 54.81   |
| Zinc in alloy produced, %       | 9       | 5         | 5         | 5         | 6       |
| Stack effluent                  |         |           |           |           |         |
| Flow rate, dscfm                | 27,515  | 30,124    | 25,406    | 27,114    | 27,540  |
| Temperature, °F                 | 118     | 107       | 106       | 113       | 111     |
| Water vapor, vol. %             | 2.66    | 1.86      | 1.85      | 1.75      | 2.03    |
| CO <sub>2</sub> , vol. % dry    | 0.60    | 0.58      | 0.60      | 0.53      | 0.58    |
| O <sub>2</sub> , vol. % dry     | 19.50   | 19.58     | 19.60     | 19.60     | 19.57   |
| Excess air at sampling point, % | 1112    | 1117      | 1205      | 1210      | 1176    |
| Visible emissions, % opacity    | <10     | <10       | <10       | <10       | <10     |
| Particulate emissions           |         |           |           |           |         |
| Probe and filter catch          |         |           |           |           |         |
| gr/dscf                         | 0.006   | 0.005     | 0.007     | 0.004     | 0.006   |
| gr/acf                          | 0.005   | 0.005     | 0.006     | 0.004     | 0.005   |
| lb/hr                           | 1.55    | 1.25      | 1.46      | 0.99      | 1.31    |
| lb/ton of product               | 0.60    | 0.41      | 0.43      | 0.42      | 0.46    |
| Total catch                     |         |           |           |           |         |
| gr/dscf                         | 0.022   | 0.007     | 0.008     | 0.006     | 0.011   |
| gr/acf                          | 0.019   | 0.006     | 0.008     | 0.005     | 0.009   |
| lb/hr                           | 5.081   | 1.692     | 1.789     | 1.356     | 2.479   |
| lb/ton of product               | 1.98    | 0.51      | 0.68      | 0.51      | 0.92    |

Table A-34. BRASS AND BRONZE FACILITIES C, E, and F,

SUMMARY OF RESULTS<sup>a</sup>

| Installation                    | C           | E         | F        |
|---------------------------------|-------------|-----------|----------|
| Run number                      | 1           | 1         | 1        |
| Date                            | 10/22-23/68 | 7/9-10/68 | 7/7-8/68 |
| Test time, minutes              | --          | 1175      | 879      |
| Heat time, minutes              | 1326        | 1174      | 874      |
| Metal charged per heat, tons    | 72          | 52.7      | 16.7     |
| Zinc in alloy produced, %       | 9           | 5         | 5        |
| Stack effluent                  |             |           |          |
| Flow rate, dscfm                | 18,052      | 27,049    | 33,999   |
| Temperature, °F                 | --          | 160       | 150      |
| Water vapor, vol. %             | 4.51        | 5.0       | 2.6      |
| CO <sub>2</sub> , vol. % dry    | 0.57        | 0.89      | 0.63     |
| O <sub>2</sub> , vol. % dry     | 19.0        | 17.9      | 18.2     |
| Excess air at sampling point, % | 791.0       | 484.0     | 535.0    |
| Visible emissions, % opacity    | --          | <10       | <10      |
| Particulate emissions           |             |           |          |
| Probe and filter catch          |             |           |          |
| gr/dscf                         | 0.013       | 0.014     | 0.005    |
| gr/acf                          | --          | --        | --       |
| lb/hr                           | 1.93        | 3.16      | 1.61     |
| lb/ton charged <sup>b</sup>     | 0.59        | 1.17      | 1.41     |
| Total catch                     |             |           |          |
| gr/dscf                         | 0.014       | 0.014     | 0.006    |
| gr/acf                          | --          | --        | --       |
| lb/hr                           | 2.17        | 3.32      | 1.78     |
| lb/ton charged <sup>b</sup>     | 0.67        | 1.23      | 1.56     |

<sup>a</sup>Tested using Code Method 4.<sup>b</sup>Tons of scrap charged was used for these calculations since ingot production rates were unavailable.

Table A-35. BRASS AND BRONZE FACILITY D,

## SUMMARY OF RESULTS

| Run number                      | 1        | 2       | 3       | Average |
|---------------------------------|----------|---------|---------|---------|
| Date                            | 11/30/71 | 12/1/71 | 12/3/71 |         |
| Test time, minutes              | 266      | 447     | 256     | 323     |
| Heat time, minutes              | 534      | 828     | 540     | 634     |
| Ingots produced per heat, tons  | 18.03    | 18.15   | 20.12   | 18.77   |
| Zinc in alloy produced, %       | 31       | 25      | 5       | 20      |
| Stack effluent                  |          |         |         |         |
| Flow rate, dscfm                | 28,582   | 36,922  | 33,857  | 33,120  |
| Temperature, °F                 | 144      | 135     | 132     | 137     |
| Water vapor, vol. %             | 1.250    | 1.240   | 1.729   | 1.406   |
| CO <sub>2</sub> , vol. % dry    | 0.300    | 0.15    | 0.700   | 0.383   |
| O <sub>2</sub> , vol. % dry     | 20.30    | 20.65   | 20.00   | 20.31   |
| Excess air at sampling point, % | 2474     | 2560    | 1828    | 2287    |
| Visible emissions, % opacity    | <10      | <10     | <10     | <10     |
| Particulate emissions           |          |         |         |         |
| Probe and filter catch          |          |         |         |         |
| gr/dscf                         | 0.006    | 0.008   | 0.010   | 0.008   |
| gr/acf                          | 0.005    | 0.007   | 0.009   | 0.007   |
| lb/hr                           | 1.431    | 2.576   | 2.929   | 2.312   |
| lb/ton of product               | 0.71     | 2.00    | 1.31    | 1.33    |
| Total catch                     |          |         |         |         |
| gr/dscf                         | 0.009    | 0.012   | 0.012   | 0.011   |
| gr/acf                          | 0.008    | 0.011   | 0.010   | 0.010   |
| lb/hr                           | 2.237    | 3.826   | 3.412   | 3.158   |
| lb/ton of product               | 1.10     | 2.92    | 1.53    | 1.85    |

Table A-36. BRASS AND BRONZE FACILITY G,

SUMMARY OF RESULTS<sup>a</sup>

| Run number            | 1       | 2       | Average |
|-----------------------|---------|---------|---------|
| Date                  | 7/15/70 | 8/20/70 |         |
| Test time, minutes    | 60      | 90      | 75      |
| Stack effluent        |         |         |         |
| Flow rate, dscfm      | 52,900  | 52,900  | 52,900  |
| Temperature, °F       | 250     | 250     | 250     |
| Particulate emissions |         |         |         |
| Total catch           |         |         |         |
| gr/dscf               | 0.015   | 0.019   | 0.017   |
| lb/hr                 | 6.80    | 8.62    | 7.71    |

<sup>a</sup>Conducted by local agency. Probe and filter catch not analysed separately.

Table A-37. BRASS AND BRONZE FACILITY H,

SUMMARY OF RESULTS<sup>a</sup>

| Run number            | 1       | 2       | 3       | 4       | 5       | 6       | Average |
|-----------------------|---------|---------|---------|---------|---------|---------|---------|
| Date                  | 8/17/70 | 8/17/70 | 3/11/71 | 3/12/71 | 3/11/71 | 3/12/71 |         |
| Test time, minutes    | 60      | 60      | 60      | 60      | 60      | 60      | 60      |
| Stack effluent        |         |         |         |         |         |         |         |
| Flow rate, dscfm      | 8000    | 8000    | 4100    | 4100    | --      | --      | --      |
| Temperature, °F       | 155     | 155     | --      | --      | --      | --      | --      |
| Particulate emissions |         |         |         |         |         |         |         |
| Total catch           |         |         |         |         |         |         |         |
| gr/dscf               | 0.009   | 0.015   | 0.019   | 0.001   | 0.016   | 0.012   | 0.012   |
| lb/hr                 | 0.62    | 1.02    | 0.67    | 0.04    | --      | --      | --      |

<sup>a</sup>Conducted by local agency. Probe and filter catch not analyzed separately.

Table A-38. BRASS AND BRONZE FACILITY I,

## SUMMARY OF RESULTS

| Run number                   | 1      | 2      | 3      | Average |
|------------------------------|--------|--------|--------|---------|
| Date                         | 7/8/68 | 7/8/68 | 7/9/68 |         |
| Test time, minutes           | 60     | 60     | 60     | 60      |
| Stack effluent               |        |        |        |         |
| Flow rate, dscfm             | 33,926 | 33,807 | 36,121 | 34,618  |
| Temperature, °F              | 215    | 215    | 175    | 202     |
| Water vapor, vol. %          | 4.5    | 3.1    | 3.2    | 3.6     |
| CO <sub>2</sub> , vol. % dry | 0.65   | 0.63   | 1.43   | 9.03    |
| O <sub>2</sub> , vol. % dry  | 17.0   | 17.0   | 17.5   | 17.2    |
| CO, vol. % dry               | Nil    | Nil    | Nil    | Nil     |
| Particulate emissions        |        |        |        |         |
| Probe and filter catch       |        |        |        |         |
| gr/dscf                      | 0.012  | 0.007  | 0.010  | 0.010   |
| lb/hr                        | 3.49   | 2.04   | 3.21   | 2.91    |
| Total catch                  |        |        |        |         |
| gr/dscf                      | 0.018  | 0.011  | 0.021  | 0.017   |
| lb/hr                        | 5.18   | 3.32   | 6.39   | 4.96    |

IRON AND STEEL MILLS  
BASIC OXYGEN PROCESS FURNACES

Six emission tests were performed by EPA and EPA contractors on six basic oxygen process furnace (BOPF) facilities. The particulate control systems included two electrostatic precipitator systems, one open-hood venturi scrubber system, and two movable closed-hood venturi scrubber systems. Closed-hood Facility A was tested in November 1971 and again in February 1972. There were no visible emissions from any of the plants tested except Facility D.

Each facility consists of two or three BOPFs. Normally, two furnaces are operated at any one time, with the third undergoing routine rebricking and maintenance. Each test consisted of four or six cycles of the furnaces. Testing was initiated immediately after the furnace was charged and discontinued just prior to tapping. Only one furnace was blown with oxygen during any cycle.

Facilities:

- A. Rated capacity each vessel--220 tons of steel per heat, equipped with a closed-hood venturi scrubber system.
- B. Rated capacity each vessel--200 tons of steel per heat, equipped with a closed-hood venturi scrubber system.
- C. Rated capacity each vessel--140 tons of steel per heat, equipped with an open hood ducted to a common electrostatic precipitator.

- D. Rated capacity each vessel--325 tons of steel per heat, each vessel equipped with an open hood ducted to a common venturi scrubber system. Oil is burned in the hood between oxygen blows to give a constant steam supply.
- E. Rated capacity each vessel--250 tons of steel per heat, equipped with an open hood ducted to a common electrostatic precipitator.

Table A-39. BOPF FACILITY A<sub>1</sub>,

## SUMMARY OF RESULTS

| Run number                               | 1       | 2             | 3       | Average |
|------------------------------------------|---------|---------------|---------|---------|
| Date                                     | 1/26/72 | 1/27/72       | 1/27/72 |         |
| Test time, minutes                       | 173     | 154           | 156     | 161     |
| Net output (six heats),<br>tons of steel | 1381.0  | 1372.5        | 1361.2  | 1371.6  |
| Stack effluent                           |         |               |         |         |
| Flow rate, dscfm                         | 58,600  | 55,600        | 58,600  | 57,600  |
| Flow rate, dscf/<br>ton steel            | 7341    | 6239          | 6716    | 6765    |
| Temperature, °F                          | 123     | 125           | 129     | 126     |
| Water vapor, vol. %                      | 13.4    | 13.6          | 12.6    | 13.2    |
| CO <sub>2</sub> , vol. % dry             |         | Orsat not run |         |         |
| O <sub>2</sub> , vol. % dry              |         | Orsat not run |         |         |
| CO, vol. % dry <sup>a</sup>              |         | Orsat not run |         |         |
| Visible emissions,<br>% opacity          | 0       | 0             | 0       | 0       |
| Particulate emissions                    |         |               |         |         |
| Probe and filter catch                   |         |               |         |         |
| gr/dscf                                  | 0.002   | 0.002         | 0.005   | 0.003   |
| gr/acf                                   | 0.002   | 0.001         | 0.004   | 0.002   |
| lb/ton of steel                          | 0.0021  | 0.0015        | 0.0048  | 0.0028  |
| Total catch                              |         |               |         |         |
| gr/dscf                                  | 0.005   | 0.004         | 0.006   | 0.005   |
| gr/acf                                   | 0.004   | 0.003         | 0.005   | 0.004   |
| lb/ton of steel                          | 0.0048  | 0.0034        | 0.0061  | 0.0047  |

<sup>a</sup>Stack gases analyzed at point downstream of scrubber but upstream of flare.

Table A-40. BOPF FACILITY A<sub>2</sub>,

## SUMMARY OF RESULTS

| Run number                               | 1        | 2           | 3        | Average |
|------------------------------------------|----------|-------------|----------|---------|
| Date                                     | 11/16/71 | 11/16-17/71 | 11/18/71 |         |
| Test time, minutes                       | 162      | 149         | 168      | 160     |
| Net output (six heats),<br>tons of steel | 1331.0   | 1321.3      | 1298.5   | 1316.9  |
| Stack effluent                           |          |             |          |         |
| Flow rate, dscfm                         | 58,880   | 57,808      | 59,621   | 58,769  |
| Flow rate, dscf/<br>ton steel            | 7166     | 6519        | 7714     | 7133    |
| Temperature, °F                          | 119      | 117         | 125      | 120     |
| Water vapor, vol. %                      | 12.9     | 12.9        | 9.8      | 11.9    |
| CO <sub>2</sub> , vol. % dry             | 13.0     | 19.2        | 20.8     | 17.7    |
| O <sub>2</sub> , vol. % dry              | 8.0      | 7.3         | 7.6      | 7.6     |
| CO, vol. % dry <sup>a</sup>              | 27.0     | 22.0        | 19.0     | 22.7    |
| Visible emissions,<br>% opacity          | 0        | 0           | 0        | 0       |
| Particulate emissions                    |          |             |          |         |
| Probe and filter catch                   |          |             |          |         |
| gr/dscf                                  | 0.002    | 0.009       | 0.003    | 0.005   |
| gr/acf                                   | 0.002    | 0.007       | 0.002    | 0.004   |
| lb/ton of steel                          | 0.0020   | 0.0083      | 0.0031   | 0.0044  |
| Total catch                              |          |             |          |         |
| gr/dscf                                  | 0.005    | 0.014       | 0.005    | 0.004   |
| gr/acf                                   | 0.004    | 0.011       | 0.004    | 0.006   |
| lb/ton of steel                          | 0.0052   | 0.0135      | 0.0052   | 0.0039  |

<sup>a</sup>Stack gases analyzed at point downstream of scrubber but upstream of flare.

Table A-41. BOPF FACILITY B,

## SUMMARY OF RESULTS

| Run number                               | 1               | 2        | 3        | Average |
|------------------------------------------|-----------------|----------|----------|---------|
| Date                                     | 10/20/71        | 10/21/71 | 10/23/71 |         |
| Test time, minutes                       | 222             | 255      | 224      | 234     |
| Net output (six heats),<br>tons of steel | 1214.3          | 1202.7   | 1223.8   | 1213.6  |
| Stack effluent                           |                 |          |          |         |
| Flow rate, dscfm                         | 37,154          | 32,020   | 48,787   | 39,300  |
| Flow rate, dscf/<br>ton steel            | 6792            | 6788     | 8930     | 7503    |
| Temperature, °F                          | 154             | 161      | 126      | 148     |
| Water vapor, vol. %                      | 10.5            | 12.7     | 13.4     | 12.2    |
| CO <sub>2</sub> , vol. % dry             | 10.4            | 9.4      | 10.8     | 10.2    |
| O <sub>2</sub> , vol. % dry              | 8.7             | 9.7      | 7.5      | 8.6     |
| CO, vol. % dry <sup>a</sup>              | 27.2            | 25.2     | 36.7     | 29.7    |
| Visible emissions,<br>% opacity          | 0               | 0        | 0        | 0       |
| Particulate emissions                    |                 |          |          |         |
| Probe and filter catch                   |                 |          |          |         |
| gr/dscf                                  | 0.012           | 0.014    | 0.011    | 0.012   |
| gr/acf                                   | 0.009           | 0.011    | 0.009    | 0.010   |
| lb/ton of steel                          | 0.0116          | 0.0141   | 0.0141   | 0.0133  |
| Total catch                              |                 |          |          |         |
| gr/dscf                                  | -- <sup>b</sup> | 0.016    | 0.012    | 0.014   |
| gr/acf                                   | --              | 0.012    | 0.010    | 0.011   |
| lb/ton of steel                          | --              | 0.0159   | 0.0158   | 0.0158  |

<sup>a</sup>Stack gases analyzed at point downstream of scrubber but upstream of flare.

<sup>b</sup>The impinger catch of Run 1 was contaminated with stopcock grease.

Table A-42. BOPF FACILITY C,

## SUMMARY OF RESULTS

| Run number                                | 1        | 2        | 3        | Average |
|-------------------------------------------|----------|----------|----------|---------|
| Date                                      | 11/10/71 | 11/10/71 | 11/11/71 |         |
| Test time, minutes                        | 141      | 148      | 164      | 151     |
| Net output (four heats),<br>tons of steel | 569.2    | 601.5    | 586.0    | 585.6   |
| Stack effluent                            |          |          |          |         |
| Flow rate, dscfm                          | 219,120  | 215,571  | 201,071  | 211,921 |
| Flow rate, dscf/<br>ton steel             | 54,279   | 53,042   | 56,272   | 54,531  |
| Temperature, °F                           | 238      | 246      | 234      | 238     |
| Water vapor, vol. %                       | 14.6     | 14.8     | 15.0     | 14.8    |
| CO <sub>2</sub> , vol. % dry              | 6.2      | 1.8      | 5.1      | 4.4     |
| O <sub>2</sub> , vol. % dry               | 16.6     | 19.2     | 17.4     | 17.7    |
| CO, vol. % dry                            | <1       | <1       | <1       | <1      |
| Visible emissions,<br>% opacity           | 0        | 0        | 0        | 0       |
| Particulate emissions                     |          |          |          |         |
| Probe and filter catch                    |          |          |          |         |
| gr/dscf                                   | 0.009    | 0.005    | 0.006    | 0.007   |
| gr/acf                                    | 0.006    | 0.003    | 0.004    | 0.004   |
| lb/ton of steel                           | 0.0730   | 0.0370   | 0.0471   | 0.0524  |
| Total catch                               |          |          |          |         |
| gr/dscf                                   | 0.014    | 0.008    | 0.010    | 0.011   |
| gr/acf                                    | 0.009    | 0.005    | 0.006    | 0.007   |
| lb/ton of steel                           | 0.1070   | 0.0631   | 0.0779   | 0.0826  |

Table A-43. BOPF FACILITY D,

## SUMMARY OF RESULTS

| Run number                                | 1         | 2               | 3               | Average |
|-------------------------------------------|-----------|-----------------|-----------------|---------|
| Date                                      | 12/8-9/71 | 12/10/71        | 12/10/71        |         |
| Test time, minutes                        | 130       | 126             | 158             | 138     |
| Net output (four heats),<br>tons of steel | 1376.6    | 1357.2          | 1368.1          | 1367.3  |
| Stack effluent                            |           |                 |                 |         |
| Flow rate, dscfm                          | 224,900   | 217,982         | 214,100         | 218,994 |
| Flow rate, dscf/<br>ton steel             | 21,239    | 20,237          | 24,726          | 22,067  |
| Temperature, °F                           | 134       | 144             | 137             | 138     |
| Water vapor, vol. %                       | 16.2      | 15.4            | 12.6            | 14.7    |
| CO <sub>2</sub> , vol. % dry              | 1.2       | 1.0             | 1.0             | 1.1     |
| O <sub>2</sub> , vol. % dry               | 19.3      | 19.9            | 19.9            | 19.7    |
| CO, vol. % dry                            | <1        | <1              | <1              | <1      |
| Visible emissions,<br>% opacity           | 0 to 20   | 0 to 20         | 0 to 20         | 0 to 20 |
| Particulate emissions                     |           |                 |                 |         |
| Probe and filter catch                    |           |                 |                 |         |
| gr/dscf                                   | 0.035     | -- <sup>a</sup> | -- <sup>a</sup> | --      |
| gr/acf                                    | 0.026     | --              | --              | --      |
| lb/ton of steel                           | 0.106     | --              | --              | --      |
| Total catch                               |           |                 |                 |         |
| gr/dscf                                   | 0.042     | 0.040           | 0.028           | 0.0368  |
| gr/acf                                    | 0.031     | 0.029           | 0.021           | 0.027   |
| lb/ton of steel                           | 0.1270    | 0.1160          | 0.0996          | 0.1142  |

<sup>a</sup>The filter in Runs 2 and 3 leaked, and it is impossible to separate the front half catch from the total catch for these runs.

Table A-44. BOPF FACILITY E,

## SUMMARY OF RESULTS

| Run number                                | 1       | 2          | 3          | Average |
|-------------------------------------------|---------|------------|------------|---------|
| Date                                      | 1/12/72 | 1/12-13/72 | 1/13-14/72 |         |
| Test time, minutes                        | 122     | 121        | 115        | 119     |
| Net output (four heats),<br>tons of steel | 1101.5  | 1102.9     | 1087.9     | 1097.4  |
| Stack effluent                            |         |            |            |         |
| Flow rate, dscfm                          | 522,332 | 496,657    | 461,571    | 493,920 |
| Flow rate, dscf/<br>ton steel             | 57,852  | 54,486     | 48,792     | 53,742  |
| Temperature, °F                           | 198     | 196        | 206        | 200     |
| Water vapor, vol. %                       | 16.0    | 19.1       | 20.8       | 18.6    |
| CO <sub>2</sub> , vol. % dry              | 4.3     | 4.9        | 4.9        | 4.7     |
| O <sub>2</sub> , vol. % dry               | 17.6    | 16.7       | 16.7       | 17.0    |
| CO, vol. % dry                            | <1      | <1         | <1         | <1      |
| Visible emissions,<br>% opacity           | 0       | 0          | 0          | 0       |
| Particulate emissions                     |         |            |            |         |
| Probe and filter catch                    |         |            |            |         |
| gr/dscf                                   | 0.020   | 0.045      | 0.016      | 0.027   |
| gr/acf                                    | 0.014   | 0.030      | 0.010      | 0.018   |
| lb/ton of steel                           | 0.169   | 0.352      | 0.109      | 0.210   |
| Total catch                               |         |            |            |         |
| gr/dscf                                   | 0.029   | 0.052      | 0.023      | 0.035   |
| gr/acf                                    | 0.020   | 0.034      | 0.015      | 0.023   |
| lb/ton of steel                           | 0.244   | 0.402      | 0.161      | 0.269   |

SEWAGE TREATMENT PLANTS  
SEWAGE SLUDGE INCINERATORS

Stack tests were conducted on five sludge incinerators including three multiple hearth units and two fluid bed reactors. One installation was tested both by EPA and a State agency. Four of the incinerators were controlled by impingement-type scrubbers, one was controlled by a venturi scrubber. Pressure drops across the scrubbers ranged from 2.5 to 18 inches of water.

Facilities:

- A. Fluidized bed reactor, 1100-lb/hr dry solids design capacity, operated at 100 percent capacity during test, equipped with a 20-inch-of-water pressure-drop venturi scrubber operated at 18 inches water pressure drop. Tested by EPA and by a State agency, latter using Code Method 8.
- B. Multiple hearth (six hearths) Herreshoff incinerator, 750-lb/hr dry solids design capacity, operated at 64 percent capacity during test, equipped with a 6.0 inch-of-water-pressure-drop single-cross-flow perforated-plate impinjet scrubber.
- C. Multiple hearth (six hearths) Herreshoff incinerator, 900-lb/hr dry solids design capacity, operated at 35 percent capacity during test, equipped with a 6.0-inch-water-pressure-drop single-cross-flow perforated-plate impinjet scrubber.
- D. Fluidized bed reactor, 500-lb/hr dry solids design capacity, operated at 95 percent capacity during test, equipped with a 4.0-inch-water-pressure-drop single-cross-flow perforated-plate impinjet scrubber.

- E. Multiple hearth Herreshoff incinerator, 2500-lb/hr dry solids design capacity, operated at about 50 percent capacity during tests, equipped with a 2.5-inch-water-pressure-drop cyclonic inertial jet scrubber.

Table A-45. SLUDGE INCINERATOR FACILITY A<sub>1</sub>,

## SUMMARY OF RESULTS

| Run number                              | 1       | 2       | 3       | Average |
|-----------------------------------------|---------|---------|---------|---------|
| Date                                    | 1-11-72 | 1-12-72 | 1-12-72 |         |
| Test time, minutes                      | 108     | 108     | 108     | 108     |
| Furnace feed rate,<br>ton/hr dry solids | 0.550   | 0.560   | 0.560   | 0.557   |
| Stack effluent                          |         |         |         |         |
| Flow rate, dscfm                        | 2880    | 2550    | 2660    | 2700    |
| Flow rate, dscf/ton<br>feed             | 314,000 | 273,000 | 285,000 | 291,000 |
| Temperature, °F                         | 59      | 59      | 59      | 59      |
| Water vapor, vol. %                     | 1.93    | 1.92    | 2.23    | 2.03    |
| CO <sub>2</sub> , vol. % dry            | 12.8    | 12.6    | 11.5    | 12.3    |
| O <sub>2</sub> , vol. % dry             | 4.8     | 4.7     | 6.4     | 5.3     |
| CO, vol. % dry                          | 0.0     | 0.0     | 0.0     | 0.0     |
| SO <sub>2</sub> emissions, ppm          | <0.3    | <0.3    | <0.3    | <0.3    |
| NO <sub>x</sub> emissions, ppm          | 4.2     | 5.7     | 6.4     | 5.4     |
| HCl emissions, ppm                      | <3.8    | <2.9    | <4.1    | <3.6    |
| Visible emissions,<br>% opacity         | <10     | <10     | <10     | <10     |
| Particulate emissions                   |         |         |         |         |
| Probe and filter catch                  |         |         |         |         |
| gr/dscf                                 | 0.024   | 0.005   | 0.004   | 0.011   |
| gr/acf                                  | 0.023   | 0.005   | 0.004   | 0.011   |
| lb/hr                                   | 0.583   | 0.116   | 0.099   | 0.266   |
| lb/ton of feed                          | 1.06    | 0.207   | 0.177   | 0.481   |
| Total catch                             |         |         |         |         |
| gr/dscf                                 | 0.032   | 0.007   | 0.010   | 0.0163  |
| gr/acf                                  | 0.031   | 0.007   | 0.010   | 0.016   |
| lb/hr                                   | 0.779   | 0.160   | 0.227   | 0.389   |
| lb/ton of feed                          | 1.42    | 0.286   | 0.405   | 0.704   |

Table A-46. SLUDGE INCINERATOR FACILITY A<sub>2</sub>,

SUMMARY OF RESULTS<sup>a</sup>

| Run number                                       | 1       | 2       | 3       | Average |
|--------------------------------------------------|---------|---------|---------|---------|
| Date                                             | 5-3-71  | 5-4-71  | 5-4-71  |         |
| Test time, minutes                               | 60      | 60      | 60      | 60      |
| Furnace feed rate,<br>ton/hr dry solids          | 0.325   | 0.325   | 0.325   | 0.325   |
| Stack effluent                                   |         |         |         |         |
| Flow rate, dscfm                                 | 3480    | 3600    | 3320    | 3470    |
| Flow rate, dscf/ton<br>feed                      | 642,500 | 664,600 | 612,900 | 640,600 |
| Temperature, °F                                  | 80      | 80      | 78      | 79      |
| Water vapor, vol. %                              | 3.4     | 3.4     | 3.4     | 3.4     |
| CO <sub>2</sub> , vol. % dry<br>(less aux. fuel) | 4.0     | 5.1     | 4.0     | 4.4     |
| SO <sub>2</sub> emissions <sup>b</sup>           | --      | --      | --      | --      |
| Visible emissions<br>Ringelmann No. <sup>c</sup> | <1      | <1      | <1      | <1      |
| Particulate emissions                            |         |         |         |         |
| Total catch                                      |         |         |         |         |
| gr/dscf<br>(cor. to 12% CO <sub>2</sub> )        | 0.020   | 0.031   | 0.048   | 0.033   |
| gr/acf                                           | 0.019   | 0.029   | 0.047   | 0.032   |
| lb/hr                                            | 0.596   | 0.956   | 1.365   | 0.972   |
| lb/ton of feed                                   | 1.84    | 2.94    | 4.20    | 2.99    |

<sup>a</sup>Tested by local agency using Code Method 1. Probe and filter catch not analyzed separately.

<sup>b</sup>No SO<sub>2</sub> detected.

<sup>c</sup>Opacity was not recorded.

Table A-47. SLUDGE INCINERATOR FACILITY B,

## SUMMARY OF RESULTS

| Run number                               | 1            | 2        | 3                      | Average |
|------------------------------------------|--------------|----------|------------------------|---------|
| Date                                     | 10-13-71     | 10-14-71 | 10-14-71               |         |
| Test time, minutes                       | 120          | 120      | 120                    | 120     |
| Furnace feed rate,<br>tons/hr dry solids | 0.237        | 0.236    | 0.249                  | 0.241   |
| Stack effluent                           |              |          |                        |         |
| Flow rate, dscfm                         | 3300         | 2950     | 2120                   | 2790    |
| Flow rate, dscf/ton<br>feed              | 835,000      | 750,000  | 511,000                | 699,000 |
| Temperature, °F                          | 198          | 196      | 199                    | 198     |
| Water vapor, vol. %                      | 3.64         | 4.02     | 3.65                   | 3.77    |
| CO <sub>2</sub> , vol. % dry             | 3.8          | 4.7      | 2.7                    | 3.7     |
| O <sub>2</sub> , vol. % dry              | 17.3         | 1.40     | 15.8                   | 15.7    |
| CO, vol. % dry                           | 0.0          | 0.0      | 0.0                    | 0.0     |
| SO <sub>2</sub> emissions, ppm           | 2.29 to 2.57 | 2.75     | --                     | 2.53    |
| NO <sub>x</sub> emissions, ppm           | --           | --       | 44.2 to 24.3<br>14.3   | 27.6    |
| HCl emissions, ppm                       | --           | --       | 0.624 to 1.33<br>0.621 | 0.858   |
| Visible emissions,<br>% opacity          | <10          | <10      | <10                    | <10     |
| Particulate emissions                    |              |          |                        |         |
| Probe and filter catch                   |              |          |                        |         |
| gr/dscf                                  | 0.0245       | 0.0196   | 0.0173                 | 0.0205  |
| gr/acf                                   | 0.0187       | 0.0155   | 0.0132                 | 0.0158  |
| lb/hr                                    | 0.690        | 0.495    | 0.315                  | 0.500   |
| lb/ton of feed                           | 2.91         | 2.10     | 1.26                   | 2.09    |
| Total catch                              |              |          |                        |         |
| gr/dscf                                  | 0.0374       | 0.0374   | 0.0457                 | 0.0402  |
| gr/acf                                   | 0.0289       | 0.0287   | 0.0348                 | 0.0308  |
| lb/hr                                    | 1.06         | 0.945    | 0.832                  | 0.946   |
| lb/ton of feed                           | 4.47         | 4.00     | 3.34                   | 3.94    |

Table A-48. SLUDGE INCINERATOR FACILITY C,

## SUMMARY OF RESULTS

| Run number                               | 1            | 2            | 3                           | Average |
|------------------------------------------|--------------|--------------|-----------------------------|---------|
| Date                                     | 7-15-71      | 7/15/71      | 7-16-71                     |         |
| Test time, minutes                       | 80           | 80           | 80                          | 80      |
| Furnace feed rate,<br>tons/hr dry solids | 0.111        | 0.149        | 0.146                       | 0.135   |
| Stack effluent                           |              |              |                             |         |
| Flow rate, dscfm                         | 1230         | 1490         | 1300                        | 1373    |
| Flow rate, dscf/ton<br>feed              | 665,000      | 600,000      | 5,000                       | 613,000 |
| Temperature, °F                          | 80           | 80           | 77                          | 79      |
| Water vapor, vol. %                      | 3.23         | 3.00         | 2.95                        | 3.06    |
| CO <sub>2</sub> , vol. % dry             | 10.0         | 10.1         | 10.2                        | 10.1    |
| O <sub>2</sub> , vol. % dry              | 7.7          | 7.3          | 7.4                         | 7.5     |
| CO, vol. % dry                           | 0.0          | 0.0          | 0.0                         | 0.0     |
| SO <sub>2</sub> emissions, ppm           | 15.9 to 11.9 | 14.5 to 14.6 | 14.6 to 13.3                | 14.2    |
| NO <sub>x</sub> emissions, ppm           | 402 to 140   | 90.8 to 74.3 | 14.5 to 142<br>50.6 to 61.8 | 163     |
| HCl emissions, ppm                       | 3.50 to 2.62 | 2.33 to 2.62 | 2.52 to 2.62                | 2.72    |
| Visible emissions,<br>% opacity          | <10          | <10          | <10                         | <10     |
| Particulate emissions                    |              |              |                             |         |
| Probe and filter catch                   |              |              |                             |         |
| gr/dscf                                  | 0.0127       | 0.0620       | 0.0196                      | 0.0314  |
| gr/acf                                   | 0.00985      | 0.0477       | 0.0152                      | 0.0242  |
| lb/hr                                    | 0.127        | 0.620        | 0.196                       | 0.314   |
| lb/ton of feed                           | 1.14         | 4.16         | 1.34                        | 2.21    |
| Total catch                              |              |              |                             |         |
| gr/dscf                                  | 0.0195       | 0.0696       | 0.0260                      | 0.0384  |
| gr/acf                                   | 0.0150       | 0.0535       | 0.0201                      | 0.0295  |
| lb/hr                                    | 0.206        | 0.889        | 0.312                       | 0.469   |
| lb/ton of feed                           | 1.86         | 5.97         | 2.14                        | 3.23    |

Table A-49. SLUDGE INCINERATOR FACILITY D,

## SUMMARY OF RESULTS

| Run number                               | 1            | 2            | 3                    | Average |
|------------------------------------------|--------------|--------------|----------------------|---------|
| Date                                     | 7-21-71      | 7-21-71      | 7-22-71              |         |
| Test time, minutes                       | 120          | 96           | 96                   | 104     |
| Furnace feed rate,<br>tons/hr dry solids | 0.255        | 0.237        | 0.202                | 0.231   |
| Stack effluent                           |              |              |                      |         |
| Flow rate, dscfm                         | 1190         | 1170         | 1240                 | 1200    |
| Flow rate, dscf/ton<br>feed              | 280,000      | 296,000      | 368,000              | 315,000 |
| Temperature, °F                          | 99           | 99           | 95                   | 98      |
| Water vapor, vol. %                      | 3.92         | 4.09         | 3.48                 | 3.83    |
| CO <sub>2</sub> , vol. % dry             | 8.8          | 9.9          | 9.1                  | 9.3     |
| O <sub>2</sub> , vol. % dry              | 6.3          | 7.4          | 8.2                  | 7.3     |
| CO, vol. % dry                           | 0.0          | 0.0          | 0.0                  | 0.0     |
| SO <sub>2</sub> emissions, ppm           | 8.29 to 11.2 | 14.8 to 14.8 | 14.2 to 15.4<br>17.8 | 13.8    |
| NO <sub>x</sub> emissions, ppm           | 154 to 168   | 41.2 to 42.9 | 187 to 170<br>161    | 132     |
| HCl emissions, ppm                       | 0.780 to 260 | 4.16 to 1.56 | 2.35 to 2.09         | 2.26    |
| Visible emissions,<br>% opacity          | <10          | <10          | <10                  | <10     |
| Particulate emissions                    |              |              |                      |         |
| Probe and filter catch                   |              |              |                      |         |
| gr/dscf                                  | 0.0551       | 0.0766       | 0.0545               | 0.0621  |
| gr/acf                                   | 0.0463       | 0.0650       | 0.0467               | 0.0528  |
| lb/hr                                    | 0.562        | 0.768        | 0.579                | 0.636   |
| lb/ton of feed                           | 2.20         | 3.24         | 2.87                 | 2.77    |
| Total catch                              |              |              |                      |         |
| gr/dscf                                  | 0.0665       | 0.0859       | 0.0653               | 0.0726  |
| gr/acf                                   | 0.0565       | 0.0729       | 0.0559               | 0.0618  |
| lb/hr                                    | 0.678        | 0.861        | 0.694                | 0.744   |
| lb/ton of feed                           | 2.66         | 3.63         | 3.43                 | 3.24    |

Table A-50. SLUDGE INCINERATOR FACILITY E,

## SUMMARY OF RESULTS

| Run number                               | 1            | 2            | 3            | Average |
|------------------------------------------|--------------|--------------|--------------|---------|
| Date                                     | 8-5-71       | 8-5-71       | 8-5-71       |         |
| Test time, minutes                       | 96           | 96           | 96           | 96      |
| Furnace feed rate,<br>tons/hr dry solids | 0.689        | 0.855        | 0.290        | 0.611   |
| Stack effluent                           |              |              |              |         |
| Flow rate, dscfm                         | 9840         | 8510         | 10,290       | 9547    |
| Flow rate, dscf/ton<br>feed              | --           | --           | --           | --      |
| Temperature, °F                          | 135          | 145          | 145          | 142     |
| Water vapor, vol. %                      | 16.3         | 18.6         | 14.8         | 16.6    |
| CO <sub>2</sub> , vol. % dry             | 4.2          | 4.3          | 2.2          | 3.6     |
| O <sub>2</sub> , vol. % dry              | 14.9         | 14.9         | 16.9         | 15.6    |
| CO, vol. % dry                           | 0.0          | 0.0          | 0.0          | 0.0     |
| SO <sub>2</sub> emissions, ppm           | 2.01         | 2.07         | 2.12         | 2.07    |
| NO <sub>x</sub> emissions, ppm           | 62.8 to 46.0 | 83.5 to 75.8 | 44.3 to 54.7 | 61.2    |
| HCl emissions, ppm                       | 11.9         | 6.83         | 10.9         | 9.88    |
| Visible emissions,<br>% opacity          | <10          | <10          | <10          | <10     |
| Particulate emissions                    |              |              |              |         |
| Probe and filter catch                   |              |              |              |         |
| gr/dscf                                  | 0.0260       | 0.0136       | 0.0134       | 0.0177  |
| gr/acf                                   | 0.0196       | 0.0099       | 0.0101       | 0.0132  |
| lb/hr                                    | 2.19         | 0.99         | 1.18         | 1.45    |
| lb/ton of feed                           | 3.18         | 1.16         | 4.07         | 2.80    |
| Total catch                              |              |              |              |         |
| gr/dscf                                  | 0.0335       | 0.0221       | 0.0170       | 0.0242  |
| gr/acf                                   | 0.0252       | 0.0159       | 0.0128       | 0.0180  |
| lb/hr                                    | 2.83         | 1.61         | 1.50         | 1.98    |
| lb/ton of feed                           | 4.11         | 1.88         | 5.17         | 3.72    |